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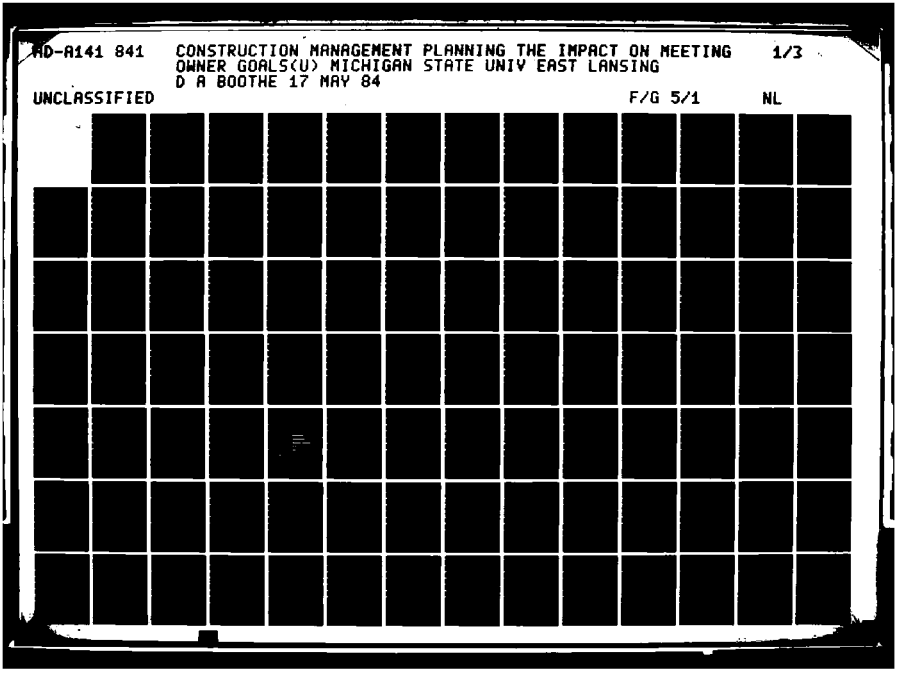

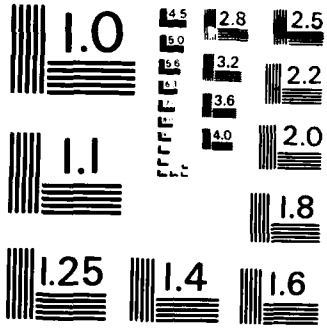

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The study was conducted through the use of a questionnaire mailed to 92 companies in Michigan who advertised that they

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The study results indicated that some aspects of planning affected the ability of the CM company to meet owner goals, although they followed no clear pattern. As measured by this study, the CM company's effectiveness was more a result of an interaction of organizational and environmental characteristics rather than the clear cut action of any planning characteristic investigated.

CONSTRUCTION MANAGEMENT PLANNING: The Impact on Meeting Owner Goals

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By

David Allan Boothe

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By

David Allan Boothe

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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MASTER OF SCIENCE

Department of Agricultural Engineering

1984

DEDICATED TO

HOWARD PAYNE BOOTHE AND ERNESTINE EATON BOOTHE

WHO ORIGINALLY MADE IT POSSIBLE

AND TO

JANET LIVESAY BOOTHE AND SHANNON McKINZIE BOOTHE

WHO NOT ONLY MADE IT POSSIBLE

BUT ALSO MAKE IT WORTHWHILE

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CHAPTER 1

INTRODUCTION

Overview

This chapter provides a sampling of several of the current meanings of Construction Management (CM) and formulates the working definition for this study. It also points out how CM can be of benefit to the construction industry. In addition, the chapter will provide a statement of the research problem addressed by this study.

Importance of the Construction Industry in the United States

The construction industry predates even the earliest historical records, and has been an important part of civilizations in every part of the world. In the United States construction is a major industry. According to U.S. government statistics, construction accounted for approximately 10% of the Gross National Product (GNP) between 1947 and 1975. Since 1975 this share has fallen to about 6% (Business Roundtable, 1983). The dollar amount used in the government's figure for put-in-place construction may be understated by as much as 25% (Business Roundtable, 1983). This is due, the Business Roundtable found, to two main reasons. First, the government defines "construction" in an

outdated and inconsistent way in gathering the figures for the value of construction put-in-place. Second, the government data-gathering procedures do not collect all the information they are intended to collect. If this understatement is true this would mean that the true value of construction put-in-place in 1979 was about $300 billion, rather than the figure of $229 billion reported by the government.

Construction is the single largest production activity of the American economy in terms of dollar value produced (Clough and Sears, 1979). If, as Clough and Sears, 1979, estimate the annual total construction expenditure is equal to approximately 12% of the GNP, then one of every eight dollars spent in this country for goods and services is a construction dollar. If, additionally, production, transportation, and distribution of construction materials is taken into account, then about 15% of the total employment in the United States is directly or indirectly created by the construction industry (Clough and Sears, 1979).

The construction industry, therefore, has an important impact on the economy of the people in the United States. The efficiency with which construction projects are accomplished, and the cost and quality of the resulting construction, affect not only the economy but also the quality of peoples lives. For this reason, techniques such as Construction Management (CM) that hold the promise of improving efficiency have become increasingly common in the construction industry.

Definition of Construction Management

The Associated General Contractors of America (AGC) define Construction Management as a method of contracting for project delivery. This method has as a central concept the use of a Construction Manager, who, as a member of the construction team composed of the Owner, the Architect-Engineer (A-E), and other consultants as needed, coordinates and manages the building process.[1] The primary emphasis is on overseeing and integrating the design and construction phases of a project.

The AGC definition of a CM (Construction Manager) says that the CM will use his/her skill and knowledge of general contracting to develop schedules; prepare project estimates; analyze alternative designs; study labor conditions; advise on construction techniques; perform value engineering; and coordinate and communicate the activities of the team, both during the design and construction phase (The Associated General Contractors of America, 1982).

The American Society of Civil Engineers defines a Professional Construction Manager as a firm or organization specializing in the practice of Construction Management. The CM should provide, as part of a management team consisting of the owner, a design organization, and CM, the

---

[1]In the remainder of this paper the terms Construction Management and Construction Manager will be used interchangeably and will be abbreviated by CM. Strictly speaking, the term Construction Management refers to a method of contracting while Construction Manager refers to the firm, but CM is used to represent either in the literature.

following services, or whatever portion is required:

1) By working with the owner and design organization from the beginning of design through completion, he/she provides leadership on all construction matters. This includes keeping the project management team informed, and, in the case of design improvements, construction technology, schedules, and construction economies, making recommendations.

2) During the planning phase he/she suggests construction and design alternatives and analyzes their effect on project cost and schedules.

3) The CM tracks the development of the project to ensure that project budgets, schedules, and quality requirements are not exceeded or sacrificed without the owner's knowledge.

4) He/She coordinates the work of all construction contractors and advises on and coordinates procurement of equipment and material.

5) The CM may monitor claims, changes, payments to contractors, and inspection for conformance to design requirements. He/She also provides current cost and progress information.

The ASCE definition also states that the CM does not usually perform significant design or construction work with his/her own forces. This is in keeping with the non-adversary relationship of the team members (ASCE, 1976).

According to Goldhaber, Jha, and Macedo (1977) CM is basically a systems approach to construction. This approach saves time because of the efficient phasing between the decision, design, and construction activities. As shown in Figure 1.1, the overlapping of the stages in the construction process--i.e., final schematic design with design development, design development with construction documents, design development with construction documents with bid, construction documents with bid, and bid with construction, in the CM approach theoretically provides a saving of time when compared with the sequential approach used by the traditional general contractor. This type of approach also realizes cost savings through design alternatives, value analysis, and package bidding, which encourages competition between subcontractors. Cost monitoring and cost control systems are also important factors in this definition.

Adrian (1981) indicated that CM was a process where a potential owner engages an agent (CM) to coordinate and communicate the entire building process. The emphasis is on minimizing the time and cost of the project through increased efficiency in coordination procedures while still maintaining the desired project quality. Figure 1.2 illustrates the conceptual differences between the CM as an agent of the owner and the traditional general contractor relationship. Adrian (1981) also noted that the most distinguishing characteristic of the CM process is the involvement

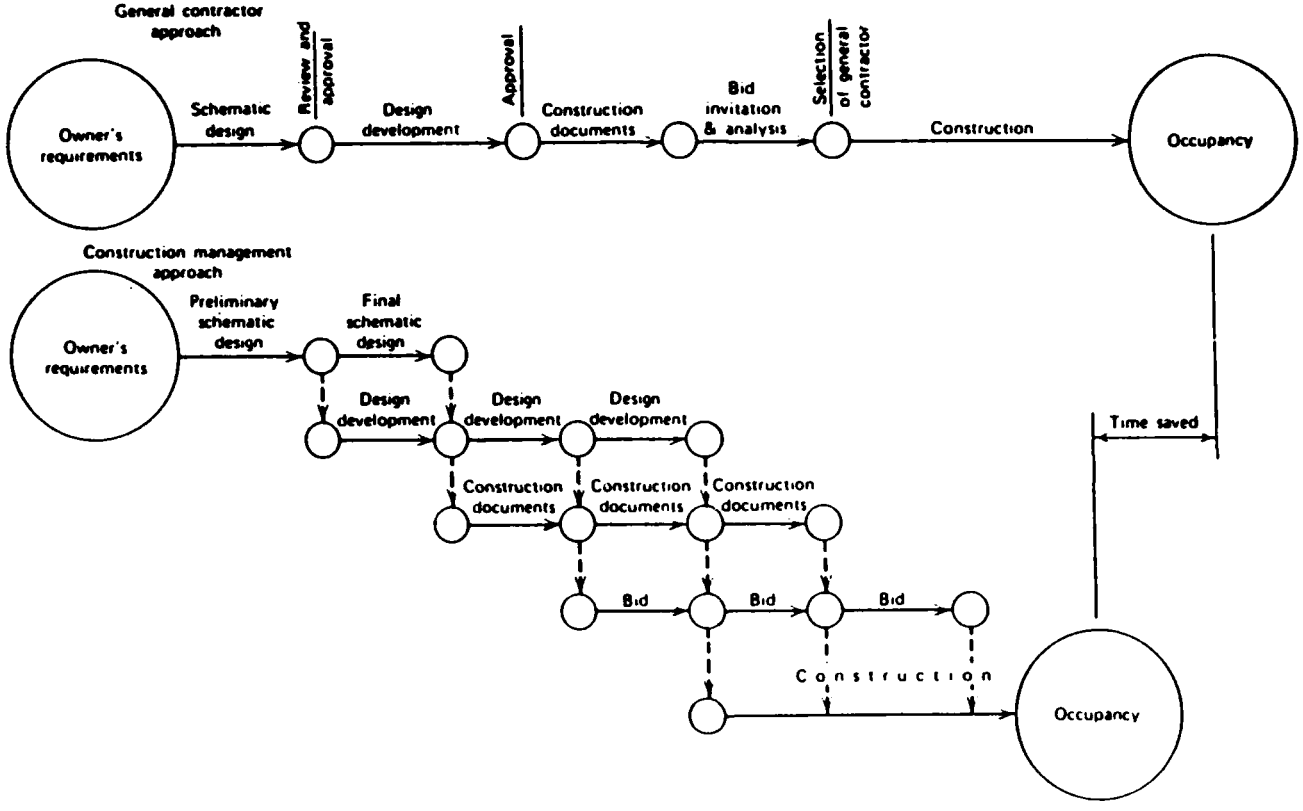
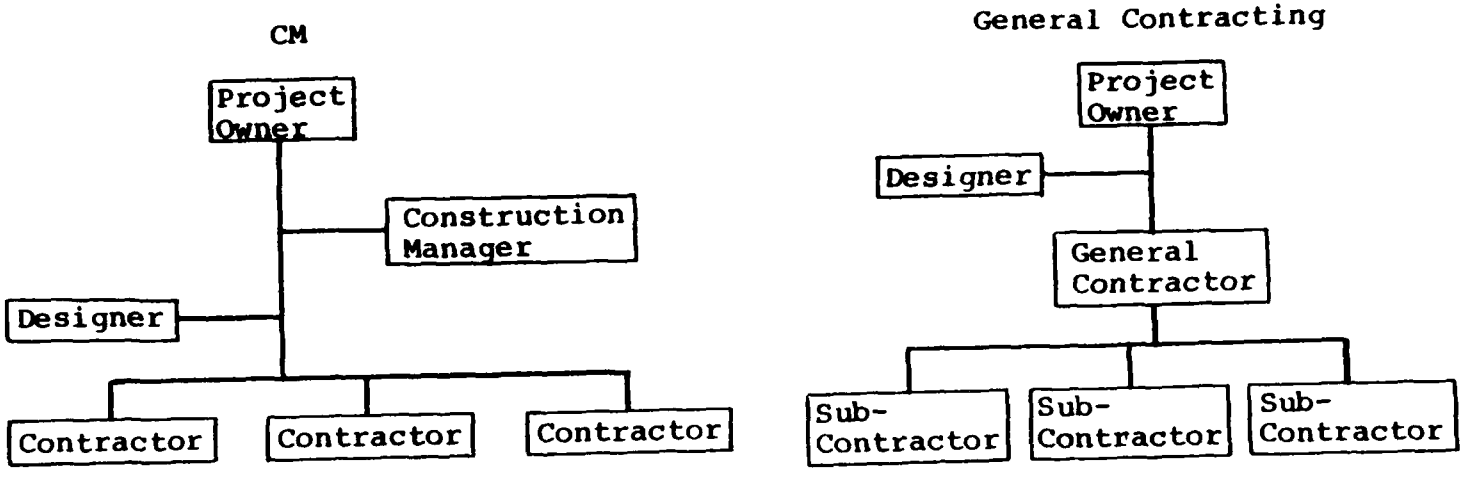


Figure 1.1 General comparison between traditional general contracting and construction management.

Source: Goldhaber, Stanley and Jha, Chandra and Macedo, Manuel C., Construction Management, Principles and Practices, (John Wiley and Sons, New York, New York, 1975), p. 15



Construction Manager:

Agent (acts for owner)

Coordinates
Communicates

Involvement Throughout

Delivers Time, Cost, and Quality to Owner

General Contractor:

Independent Contractor

Constructs

Involvement after Design

Delivers Quality to Owner and Time and Cost Primarily to Own Firm

Figure 1.2 Construction Management Versus General Contracting

Source: Adrian, James J., CM: The Construction Management Process, (Reston Publishing Company, Reston, Virginia, 1981), p. 3

of a single firm through the entire project: feasibility, design, contract letting, construction and implementation.

CM contracts are professional service contracts and are normally negotiated between the owner and CM. A basic fixed-fee, normally ranging from 2 to 5% of the estimated construction cost is agreed on for total compensation for all preconstruction and construction phase services (Goldhaber et al., 1977).

George J. Heery, writing in The Military Engineer (1974), said that when a firm represents the owner in all construction management activities, CM includes all the management activities that are related to a construction program and carried out during the pre-design, design, and construction phases of a project.

Foxhall (1972) stated that CM is a firm that applies know-how of construction techniques, conditions, and costs to the three phases of construction: decision, design, and delivery.

A concept central to all published definitions of CM is that the process is divided into two distinct phases and that each phase has some functions, offered by the CM firm, which are limited to only one phase while some functions overlap both phases. The preconstruction phase could require some or all of those functions listed in Figure 1.3 while the construction phase could require some or all of those functions listed in Figure 1.4. As was noted above, all functions in both phases, may or may not be required.

* Owner-Needs Identification Study
* Project Feasibility Study
* Tax Analysis of Project
* Marketing Research for Proposed Project
* Assistance in Obtaining Financing
* Assistance in Obtaining Permits & Zoning
* Budgeting
* Value Engineering
* Paramenter Estimating
* Scheduling of Design & Pre-Construction
* Identification of Long-Lead Items
* Bid Packaging
* Awarding Contracts
* Setting Out Operating Procedures & Responsibilities
* Process Paper Work

Figure 1.3 CM Preconstruction Services

Source: Adrian, James J., CM: The Construction Management Process, (Reston Publishing Company, Reston, Virginia, 1981), p. 47

* Detailed Planning & Scheduling
* Construction Phase Estimating
* Operating Procedures
* Supervision
* Inspection
* Testing Materials
* Handling Paper Work
* Handling Change Orders
* Cost & Time Control System
* Process Contractor Payments
* Testing the Completed Project
* Marketing the Project
* Property Management

Figure 1.4 CM Construction Services

Source: Adrian, James J., CM: The Construction Management Process, (Reston Publishing Company, Reston, Virginia, 1981), p. 55

The choice of which functions to include is a product of the owner's desires, the type and size of the project, and, of course, the contract.

A distillation of these definitions and explanations of Construction Management leaves the essentials of a firm, strong on management ability and practical construction knowledge, which is involved with a project from conceptualization to turnover of the completed project. CM is a team concept which consists of, as a minimum, the CM, the owner, and the design professional (A-E).

Although the CM process may be used to implement phased construction, the overlapping of construction stages, there is not an irrevocable link between the two. The fact that a project is being constructed utilizing the CM method does not also mean that the project is being constructed utilizing phased construction.

The Importance of CM to the Construction Effort

According to the Business Roundtable (1983) the United States is no longer getting its moneys worth from the construction industry. They cited a Commerce Department report that productivity in put-in-place new construction had dropped from an index number of 100 in 1972 to an index number of 82.9 in 1979, a drop of nearly 20%. The Business Roundtable further pointed out that this erosion of construction efficiency and productivity had a disastrous effect on the economy since the price of every new piece of

real property that is built directly affects the price for goods and services produced in it.

The Business Roundtable believed that fragmentation is the one reason that the construction industry is relatively inefficient. It is a $300 billion a year business which has been activity involving almost one million contractors and a similarly large number of owners and architects. These large numbers offer almost endless permutations, with the chances for litigation equally large.

M. R. Lefkoe (1970) wrote that contractors should view their function as making it as easy as possible for potential customers to obtain the value satisfaction that their structure would ultimately provide, rather than viewing the activity as merely putting up a structure. He thought that those contractors who accepted this new definition of construction would have to assume increased responsibilities for the entire construction process. Adrian (1981) cited two reasons for the growth of CM; one, the failure of traditional construction methods to attain the owner's time, cost, and quality objectives, and two, the compatibility of the CM process with increased project complexity. The Business Roundtable (1983) indicated that opportunities to shorten the project time and cut project costs are often passed by because the traditional construction process isolates financial planning, design, and scheduling from that of the actual construction.

A study conducted by Parvis F. Rad and Marion C. Miller (1978) found that from 1971 to 1976 the percentage of all contractor and design firms offering CM services increased 9%. They also found that, among contractor firms, the increase in the percentage of firms providing CM services was predominantly among the largest firms. Lindstrom (1982) citing from construction statistics in Building Design and Construction noted that Construction Managers boosted their commercial, industrial, and institutional (CII) volume by 27.3% in 1981 as compared to only a 12% growth overall from CII volume. CM was the area of greatest growth. In their search for methods to increase efficiency, and therefore their company's profits, construction companies were apparently turning to CM in large numbers.

The CM process has evolved from its beginning in the late 1960's as a method to integrate, under a continuity of management, all the phases of construction: conceptual planning, schematic design, design development, contract documents, bidding, and actual construction. This continuity of management, coupled with the presence of construction expertise early in the design phase, is the construction industry's response to the challenge of many critics to enter the latter part of the twentieth century and employ modern management techniques.

Although much has been written about the growth of CM, what it is, and how to implement it, the available literature is deficient in studies or articles pertaining to a

question central to the CM process. That is, are the companies who provide CM services any better off than those who do not? Logical extensions to this question, which appear to be lacking in the literature, are investigations into the specific planning techniques CM firms use and if their activities have any impact on the effectiveness with which projects are completed. This question is central to the purposes of this thesis.

Statement of the Problem

This study is directed at the preconstruction phase of CM. More specifically, the study will attempt to determine the effect of planning, during the preconstruction phase, on the effectiveness of the CM firm.

The investigation is directed towards determining the relative impact of the planning techniques, which a CM company uses during the preconstruction phase, on the effectiveness of the company and consequently on its profitability. Also the relative impacts of both selected organizational characteristics and the type of CM projects a company undertakes on the effectiveness of the company will be investigated.

The key word in this is 'relative.' That is, how does the impact of the planning done in the preconstruction phase relate to the organizational characteristics or project type. Is the impact of any of these three, or some

combination, more important to the efficiency of the CM company than any other, either singularly or in combination?

Summary

The construction industry, including its many ancillary industries, has always been an important part of the economy of the United States. According to government statistics it now accounts for 6% of the GNP although some sources feel that this is understating its importance.

The definitions of CM are as varied as the companies who engage in it or the individuals who write about it. Several professional organizations, including the ASCE and the AGC, have published definitions and guidelines in an attempt to arrive at a common meaning of the term "Construction Management."

CM is one of several methods by which the construction industry has attempted to meet public criticism of industry inefficiency and charges of poor management. Failure of traditional contracting methods to attain the owner's time, cost, and quality objectives plus the increased complexity of present day construction projects have been the major factors in the apparent growth of CM.

This study, directed at planning in the preconstruction phase of CM, is an investigation of the relative impact of the planning techniques used on the ability of a CM company to meet an owner's requirements.

CHAPTER 2

REVIEW OF LITERATURE

Overview

This chapter provides a recapitulation of the literature concerning the central question of this paper. That is the extent to which characteristics of the CM company, characteristics of the CM project or the project environment, and the planning used by the CM company during the preconstruction phase of a project all have an impact on the effectiveness of the CM company in meeting the requirements of an owner. The review is a combination of literature from the construction industry and from organizational behavior in the field of business management. In conclusion, the hypotheses drawn from this literature are presented.

CM Company Effectiveness

Goldhaber, et al. (1977) stated that the major concern of the construction industry is to erect quality buildings on schedule and within the owner's budget. They felt that the best method of combining the diverse activities of a construction project into an integrated whole is a systems approach. This approach is a process that generates a completely integrated system that is intended to accomplish one or more objectives. In the case of a construction

project that objective is a quality building, on time and within budget. They argued that CM is the system approach applied to the construction industry.

The Construction Industry Cost Effectiveness Project (Business Roundtable, 1983) recommendations, made after studying over 125 different organizations and companies, for increasing the cost effectiveness of the construction industry mainly involved ways to manage construction projects more effectively. They found that more than half the time wasted during construction was attributable to poor management, that is the lack of efficient management.

Hofer and Schendel (1978) made a distinction between effectiveness and efficiency when applied to a company. They stated that in general systems theory, effectiveness is the degree to which the actual outputs of the system (CM) correspond to its desired outputs, while efficiency is the ratio of actual outputs to actual inputs. In the construction industry these two terms, effectiveness and efficiency, appear to be used interchangeably. Hofer and Schendel (1978) went on to say that efficiency usually applied to operations internal to the company while effectiveness applied to the relationship between the company and its external environment.

Steers (1977) made the point, after studying previous research, that, at least in some cases, efficiency is not a prerequisite of effectiveness. He cited the case of a government in time of war, the government had "unlimited"

resources, where efficiency may be less important than effectiveness. On the other hand, where an organization does not have unlimited resources, efficiency may be the most important factor in facilitating organizational effectiveness. Under these constrained circumstances, efficiency allows for increased productivity. He also stated that, in highly competitive market situations, efficiency may represent survival itself.

Goldhaber, et al. (1977), felt that the system approach, CM, when properly applied helps to develop a more efficient operation that provides better quality, reduced time of work, and lower costs. Additionally, by providing better coordination and communication between specialized areas of the project, it further increases operational efficiency and the effectiveness of the company on the project.

Adrian (1981) said that the CM firm's ability to be involved in the construction process throughout design, construction, and implementation places the firm in a position to make decisions that minimize the project's time and cost and maximize project quality, thereby making the project more efficient. This introduction of a single source of management into both the design and construction stage introduces, in Adrian's words "work smarter not harder" into the construction process and that is the key to obtaining the most efficient project.

Earl M. Jennett (1972) said that theoretically, under CM, there should be a gain in efficiency through early input

or construction expertise and less need for contingency allowance.

Roy Harley (1972) said that CM aims to meet the owner's needs most efficiently. Abraham S. Bolsky (Construction Management: The Man Behind the Concept, 1972) indicated that his company had found that an experienced CM who participates in the design and then innovates in the construction process could produce savings of 25% to 33% over the cost of traditional design and construction procedures.

Dioguardi (1983) writing about the construction industry stated that for companies to function efficiently their managers must introduce and expand the use of computerized information systems. These systems are combinations of computer programs, such as CPM (Critical Path Method) and PERT (Production Evaluation and Review Technique) which are used for planning, and estimating programs.

Dimensions of Effectiveness

Sloma (1980) created a performance test for management which, due to the relationship of management to company effectiveness, could also be considered a measure of the effectiveness with which a CM company meets an owner's requirements. He asked if managers were primarily guided by market or customer needs rather than theoretical concepts. This is especially pertinent to CM because an owner's needs are a quality project delivered on time and within schedule. An owner is not primarily concerned with the 'how' but rather with the 'when' and 'how much.'

Another of Sloma's (1980) questions had to do with the amount of time spent "fire-fighting" problems rather than preventing them. This relates to the planning conducted during the preconstruction phase by the CM company.

His question regarding creating new ideas and solutions, as opposed to a "don't rock the boat" conformity is one of the central purposes in CM. This is the early use of construction knowledge to improve the design and to make alternatives available to the owner. This can save time and cost later in the project and lead to increased effectiveness in meeting the owner's requirements.

Klein and Ritti (1984) differentiated among political goals, planning goals, and action goals of an organization. Political goals are usually set at the executive level to maintain resources of sentiment and power, both inside and outside the organization, and are often stated in general terms as ideas. Political goals tell the organization that these ideas are important, but specific planning goals are generally not given.

Intended to guide choices, planning goals may be different than the more public political goals. These are set to demonstrate organizational intent and provide a basis for choice among alternatives. These types of goals usually come from middle and upper management. Action goals, those set by first level management, are goal statements which can be acted upon without further simplification (Klein and Ritti, 1984).

Taken in the context of a CM company, an example of a planning goal would be the signing of a contract for a CM project. The meeting of the owner's requirements are the organizational intent while the how, or action goals, are those actions which must be completed to meet the planning goals.

Thompson and McEwen (1958) stressed the close relationship between goal setting in the organization and the external environment in which the organization operates. In this case, environment means factors outside the organization which have the potential to influence organizational actions and success. In the construction industry, short term goals, i.e., project completion, etc., are influenced more by the company's environment than by factors internal to the company. This environment includes not only the wishes of the owner, but also competition from other companies, unions, and the complexities of federal, state, and local regulations.

As Dioguardi (1983) has pointed out, the construction company exists almost at the whim of factors in an environment external to the company itself. The ability of a construction company to continue to operate is almost wholly based upon its effectiveness in meeting goals set for it by its environment. This is not to say that the company, as Thompson and McEwen (1958) stated, has no input on maintaining a balance of power with this external environment. In the end, the company can turn down any contract for which it

feels the goals are unrealistic.

In writing on the multivariate approach to measuring organizational effectiveness, Steers (1971) found that there was a surprising lack of consensus as to what constitutes a useful set of measures of organizational effectiveness. Although each model had three or four defining characteristics of success, there was little overlap among the approaches. Only one criterion was mentioned in over half of the models he studied. This was adaptability/flexibility. This criterion was followed by productivity and satisfaction.

Management By Objectives

As described by Campbell (1980), management by objectives (MBO) represents the ultimate in a goal-oriented model of effectiveness. Rather than an organization being evaluated on a single continuum, such as a cost/benefit ratio, MBO assumes that effectiveness is some aggregation of specific, observable, and quantifiable accomplishments and failures. Either an organization accomplishes a specific task or objective set for it or it does not.

Campbell (1980) mentioned that one relevant issue with MBO is what group or individual sets the goal(s) for a particular organization. A second issue is to what extent is it possible to define quantifiable goals for the organization. Additionally, to what extent is it possible to know whether or not an objective has been met? He further stated that for a particular time period, each organization must

specify in detail the things which it wishes to accomplish.

For the CM company MBO seems to be an especially appropriate method of measuring the efficiency of its operations concerning a specific project and its (the CM company's) effectiveness from the owner's viewpoint. The objectives are exceptionally clear-cut, at least from the perspective of the owner, and are arrived at, collectively, by the CM firm and the owner with input from the design professional (A-E). The desire of the owner to have a quality project, built on time and within the budget, is quite easily translated into a yardstick by which the CM company can measure both its efficiency and its effectiveness.

Organizational Design

Burns and Stalker (1961) originated the designation of organizational structure as mechanistic or organic. Miles (1980) characterized mechanistic forms as having a rigid breakdown of roles into functional specializations, precise definitions of duties, responsibilities and power, and a well developed command hierarchy through which information filters up and decisions are instructions flow down. Organic forms are more flexible and adaptable; jobs lose much of their formal definition, and communications up and down the hierarchy are more in the nature of consultations. In addition to the characterization he felt that the organic form is more suitable for changing conditions "which give rise constantly to fresh problems and unforeseen

requirements for action which cannot be broken down or distributed automatically."

Mintzberg (1979) designated five structural configurations for organizations. They are each characterized by specific prime coordinating mechanisms, key part of the organization, and type of decentralization.

His simple structure has direct supervision as the prime coordinating mechanism and the key part of the organization is the strategic apex. Power over all important decisions is usually in the hands of the chief executive officer. Decentralization is non-existent but rather this type of organization has vertical and horizontal centralization. This structure is characterized by what it is not--elaborated.

Mintzberg's second structure is the machine bureaucracy. Its prime coordinating mechanism is standardization of work and the key part of the organization is the technostructure. Rules and regulations are the seat of power for this structure with formal communication favored at all levels. The machine bureaucracy has limited horizontal decentralization.

Another structural design for organizations is the professional bureaucracy. Standardization of skills is its prime coordinating mechanism with the key part of the organization being the operating core. The operating core is defined as where the operators carry out the basic work of the organization. In the case of the professional

bureaucracy the operating core is composed of trained and indoctrinated specialists--professionals. This structure is characterized by both vertical and horizontal decentralization.

With its prime coordinating mechanism being the standardization of outputs the divisionalized form has as its key part of the organization the middle line. This form has limited vertical decentralization.

The final organizational firm, as noted by Mintzberg (1979) is the adhocracy. This form, although it is the newest, seems to be a description of the construction company which has organized itself for CM. As noted by Mintzberg, this structure is highly organic, with little formalization of behavior; high horizontal job specialization based on formal training; a tendency to group the specialists in functional units for housekeeping purposes but to deploy them in small market-based project teams to do their work; a reliance on the liaison devices to encourage mutual adjustment--the key coordinating mechanism--within and between these teams; and selective decentralization to and within these teams. In this form, managers are abundant--functional managers, integrating managers, and especially project managers.

Dioguardi (1983) felt that, due to the fact that the construction industry is a macroeconomic sector that frequently gives rise to booms and recessions of a more or less intense character but of limited duration, the industry can

no longer operate as compact, highly integrated self-contained units that can perform all work operations themselves. The danger always looms of facing production peaks with an organizational structure too large or too small for the work actually awarded. This is why a new organizational approach needs to be developed, capable of determining interdependencies that run from a central base pole, toward various autonomous productive poses situated inside or outside the firm. This means that the larger enterprises must act as contract coordination and management firms.

Describing a military or line type organization for construction, Deatherage (1964) said that this is the old construction type where discipline was the essential feature. As shown in Figure 2.1, where the solid lines show authority and the broken lines show contract and communication, the solid lines predominate. Discipline, under this structure, is assumed to be the most important factor.

Figure 2.2 illustrates Deatherage's concept of a line and staff organization where communication and contact are at least as important as discipline.

Organizational Characteristics Related to Effectiveness

Experience

The CM Committee of the Associated General Contractors of American (AGC) found, after reviewing projects where CM had failed to meet the owner's objectives, that the cause was usually directly related to the selection of an

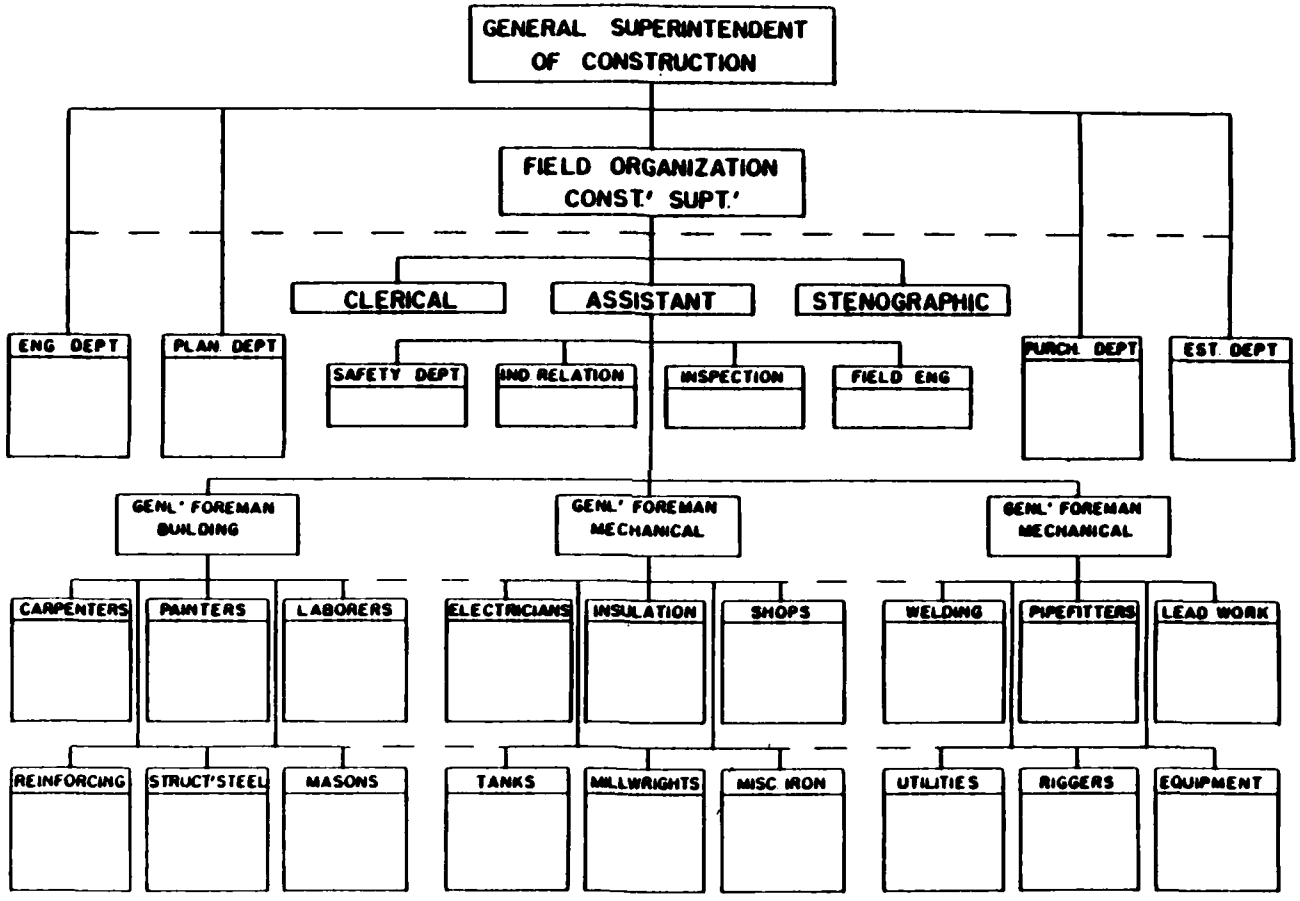


Figure 2.1. Example of military- or line-type organization.

Source: Deatherage, George E. Construction Company Organization and Management, (McGraw-Hill: New York,1964), p. 18

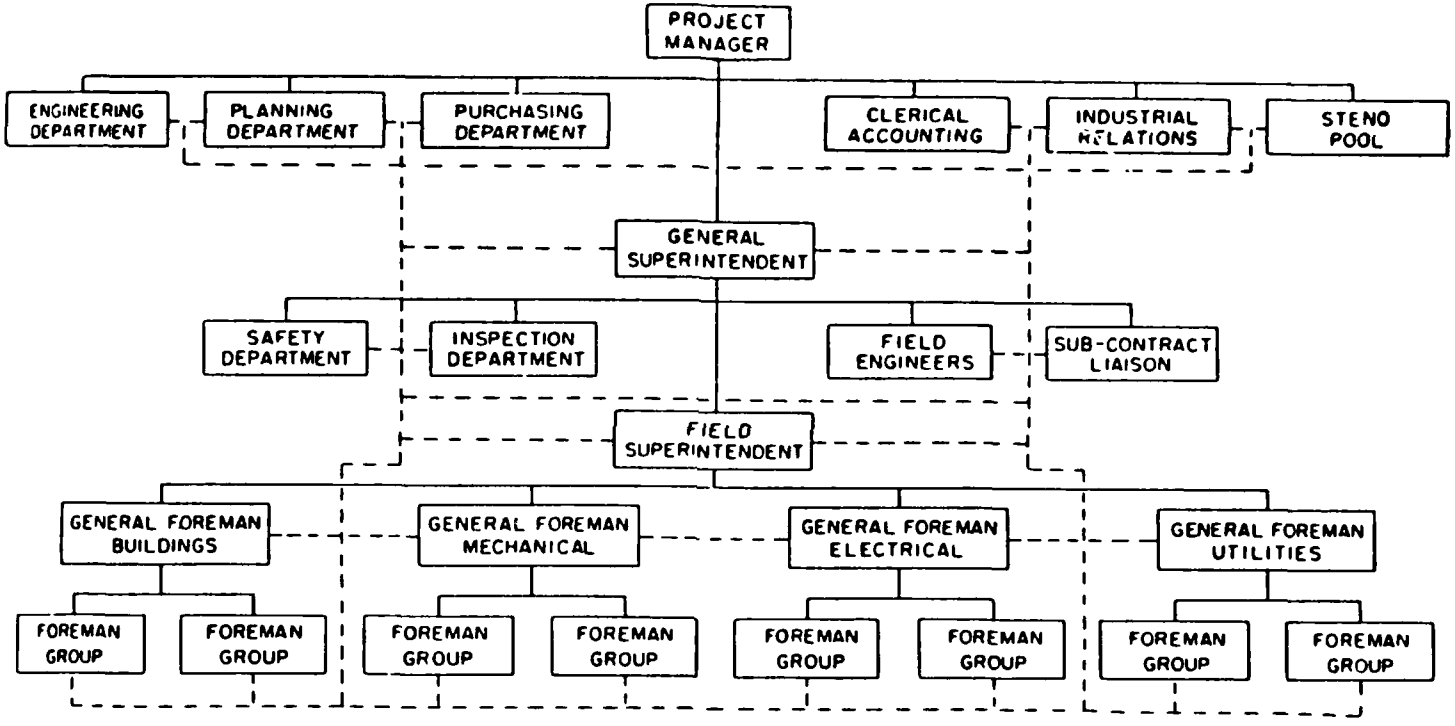


Figure 2.2. Example of line and staff organization.

Source: Deatherage, George E. Construction Company Organization and Management, (McGraw-Hill: New York, 1964),p. 19

incompetent CM (Lindstrom, 1982). The General Services Administration (GSA) feels that a CM firm's experience in the construction field in general and the CM field in particular should be a basic consideration when hiring a CM firm. Questions relating to this experience are placed on the questionnaire which prospective CM firms are requested to fill out for pre-qualification (GSA, 1975).

The AGC feels that, in the preliminary or initial consideration of possible CM prospects, the firm's recent experience would be a basic consideration. In order to narrow the field of possible CM firms, an owner should conduct a detailed investigation of past performance (AGC, 1982). This is important not only because the successful completion of comparable projects is a basic consideration to the owner, but also because it indicates the demonstrated ability of the CM in several areas.

For many attributes of CM firms experience is perhaps the best indicator of potential (Tatum, 1979). He pointed out that one of several criteria which may be used in evaluating experience is overall performance on like projects when judged by comparison of actual cost and completion date with budgets and schedules.

Organizational Size

The more sophisticated owners and buyers of construction products of today are beginning to demand that the fragmented responsibilities which heretofore have been a 'given' in the construction industry be combined for

efficiency, for assurance of quality, and for economy of products delivered in a timely manner. The client wants a single-source, broad range of professional capabilities (Fox, 1976).

The planning and execution of building projects have traditionally asked for the collaboration of a large number of partners. These partners have usually worked together for a period of time and ended their collaboration as soon as the project was finished. They are experts in their field and contribute their knowledge towards a common end, meeting the needs of the owner (Diepeveen, 1976). As Fox (1976) has noted, owners are demanding that the skills gained from working together on a project not be lost, but rather that they be combined into a form where the traditional division between roles become blurred. In this manner continuity of joint experience does not become lost (Diepeveen, 1976).

Being characterized by a highly sophisticated interaction between owner, governmental organization, local regulatory agencies, constructor, financer, designer, and subcontractors, present day projects are getting larger and more complicated (Burger and Halpin, 1976). This in turn calls for increasingly sophisticated project controls. This is true for some projects but not, by any means, all of them. Fox (1976) said that the type of builder who executes small units which are comparatively simple, but nevertheless important, cannot necessarily conceive of the organization and

control necessary in terms of computers, complex management information systems or high level expert staffs for complicated projects.

Silverman (1976) suggested the many facets and skills which are required to produce a large construction project and which must therefore be incorporated into the organization dealing with such a project. He noted that not the least of these was the management within the organization which should, hopefully, be skilled in several of the critical disciplines of the project. Silverman (1976) continued by stating that delivery of the building project must utilize a system approach and employ sophisticated systems technology to control, coordinate, and to monitor the delivery process.

Because the human element is predominant in construction this itself often takes the understanding out of an architectural/engineering context. The inference is that such work needs to be undertaken by multi-disciplinary teams (Pilcher, 1976).

The outline of the company needed to engage in CM then emerges as being one that has assets which include many disciplines. These assets should have a continuity over a large number of project and have access to sophisticated management information systems.

Information

The construction industry has been criticized for its slow acceptance and use of modern management systems to plan

and execute projects. Research has shown that ineffective management is a major demotivator on projects and that this ineffectiveness is directly traceable to the lack of modern management systems (Business Roundtable, 1982).

Tatum (1979) felt that the management ability of a CM firm may be evaluated by its commitment to expansion of management systems and the approach to systematic performance of CM tasks. In order to expand management systems, the individuals in the firm first have to be exposed to (learn about) them and be convinced of their worth.

In a large part, the practice of CM was brought about by firms in order to better meet the requirements of owners who were not satisfied with the status quo then in existence in the construction industry. It was innovative and a search for a better way. This search is still going on in the attempt to better the effectiveness of CM.

Hypotheses

Based on the literature reviewed, the following hypotheses are offered.

- The length of experience a company has with CM contracts has a positive relationship to effectiveness.
- The size of a CM company has a positive relationship to effectiveness.
- Exposure of CM managers to sources of information about new management techniques has a positive relationship to effectiveness.

Environmental Characteristics Related To Effectiveness

Project Size

The Business Roundtable (1982) has noted that construction projects are becoming larger in size and consequently in dollar value. This has not only had an effect on the organization and size of the company but also on the external environment in which the company exists. Larger, more complicated, projects involve the organization in a more complex environment.

Mintzberg (1979) believed that one facet of an organization's environment, complexity, can be thought of as simple or complex. An environment is complex to the extent that it requires the organization to have a great deal of sophisticated knowledge about products, customers, or whatever. The environment becomes simple if it can be broken down into easily comprehended components.

Complexity is viewed by Miles (1980) as one general environmental dimension. This dimension refers to the number of different organizational attributes or components of the environment. Additionally, Jurkovich (1974) said that organizations dealing with noncomplex environments have one advantage: there are fewer critically important information categories necessary for decision making.

Miles (1980) believed it is important to recognize that organizations may inherit complexity in their environment. Public sector organizations usually find the level of complexity in their environment to be mandated. As described

earlier, Dioguardi (1983) also noted this and felt that one of the construction industry's biggest problems was in coming to grips with this mandated complexity.

In discussing all of the technological needs of a construction company to meet owners' demands Pilcher (1976) added that the principles of organization are just as important to the small firm's organization, as well as to the construction industry if it is to be efficient. A logical extension of this is that the principles involved in CM can improve effectiveness for any project. Linstrom (1982) found that CM worked well on projects of $1 million in cases where the client's needs dictated phased construction and input into the design phase for specialized cost control. He believed that the process can work for any size project.

Contracting Sequence

Bosche (1976) felt that the person who gets involved with the owner first will control the organizational form in the construction business. That is, the individual (company) who gets an agreement with the owner first to be on the project team controls the organizational form and, by extension, the communication procedures.

All of the literature reviewed has made the same point. For the most effective use of the CM process the company providing the CM service should be involved from the very inception of the project. An inplace management information system is a basic requirement of a CM company and a part of the system is the plan for utilizing the information

generated, that is the communication channels.

To function effectively construction companies must have different types of communication systems: interpersonal, interdepartmental, and interorganizational. In the construction industry graphs, letters, reports, bar charts, CPM diagrams, and cost control reports are used to convey both verbal and nonverbal communication about specific information about activities on a project (Guevara and Boyer, 1981).

In a study of nine unionized construction companies in Illinois, Guevara and Boyer (1981) found that 72% of all management level employees felt that information overload, having too much information available, was a moderate or severe problem. Fifty-three percent of these same employees felt that gatekeeping, withholding information, was a problem while 59% felt that distortion of the available information was a moderate or severe problem.

Having the CM company establish the communication procedures for the CM team, owner, A-E, and CM, was seen as a major responsibility by The Associated General Contractors of America (1976), Darin and Armstrong, a major CM company in Michigan, and the Committee on Professional Construction Management of the ASCE (1979). All felt that this responsibility falls more on the CM company than on either the owner or the A-E.

Management success depends, largely, on trust to whom trust is due, what information is chosen, and how it is

effectively utilized (Bhandari, 1978). The three problems with communication in construction companies described by Guevara and Boyer (1981) are reflected by organizations suggesting guidelines for the services CM companies should provide. Those in the construction industry have expressed an interest in, and are implementing, construction management information systems such as cost accounting, scheduling, equipment selection and maintenance, cost control, and others (Bhandari, 1978).

Network Scheduling

Originated in 1957 and 1958 by the Sperry Rand Corporation for use by Dupont to schedule construction, maintenance, and shutdown of chemical process plants, the Critical Path Method (CPM) is a key element in successful construction management (McGough, 1983). At the same time, the Navy Special Projects Office developed an integrated management technique for use in the Polaris Missile Program. This was known as Program Evaluation and Review Technique (PERT). Although CPM and PERT are superficially different, both use a network to model a real project (McGough, 1983).

Scheduling management normally is activated, in some form, at the conception of the project. A management plan is developed at a low level of detail containing major milestone events, important events, for all elements of the project (McGough, 1983). This is then usually used to facilitate the preconstruction planning process. Many researchers of CM activities (Foxhall, 1972; Halpin, 1980;

Goldhaber, et al., 1977; Adrian, 1981) and professional organizations (The American Society of Civil Engineers and the Associated General Contractors of America) have felt that the use of scheduling, early on, in preconstruction planning is an important attribute of CM.

When multiple prime contracts are involved on a project the owner may choose to hire a CM company to coordinate and manage the job. The CM company will prepare and monitor a coordinated schedule based on individual schedules prepared by the prime contractors. The owner will benefit from expert assistance in schedule coordination but still be able to maintain a close overview of the project (Galloway and Nielsen, 1981).

Hypotheses

Based on the literature reviewed, the following hypotheses will be tested.

- Using a network based scheduling system during preconstruction planning has a positive relationship to effectiveness.
- Being hired as CM prior to the hiring of the A-E has a positive relationship to effectiveness.
- The CM firm establishing communication procedures for the management team (CM, owner, A-E) has a positive relationship to effectiveness.
- Project size has no relationship to CM effectiveness.

Planning Characteristics Related To Effectiveness

Clough and Sears (1979) described planning as being that activity which, on the basis of a detailed study of the job requirements, establishes what is to be done, how it is to be done, and the order in which it will proceed.

The traditional view of planning in the construction industry has planning being synonymous with scheduling of the project. Densmore and Burgoine (1981) stated that in any undertaking for the successful completion of a project, there must be a clear understanding of what is required, when it is to be done, and by whom. The emphasis here is on project planning. If proper planning is achieved, then, ideally, the project is completed by the best use of the available resources.

As shown in Figure 2.3, Densmore and Burgoine (1981) viewed project planning as having six principal elements: the definition of the work, preparation of the scope of the work activities, allocation of responsibilities and preparation of project plan, developing the project organization, and administrative procedures. Figure 2.3 shows the planning phase in network form. The interdependence between areas is also depicted.

The reasons for managers failing to plan their activities adequately and to set specific targets or goals for performance are many. Steers (1977) listed several which he found important. First was the issue of accountability, that is the more specific managers are in setting goals the

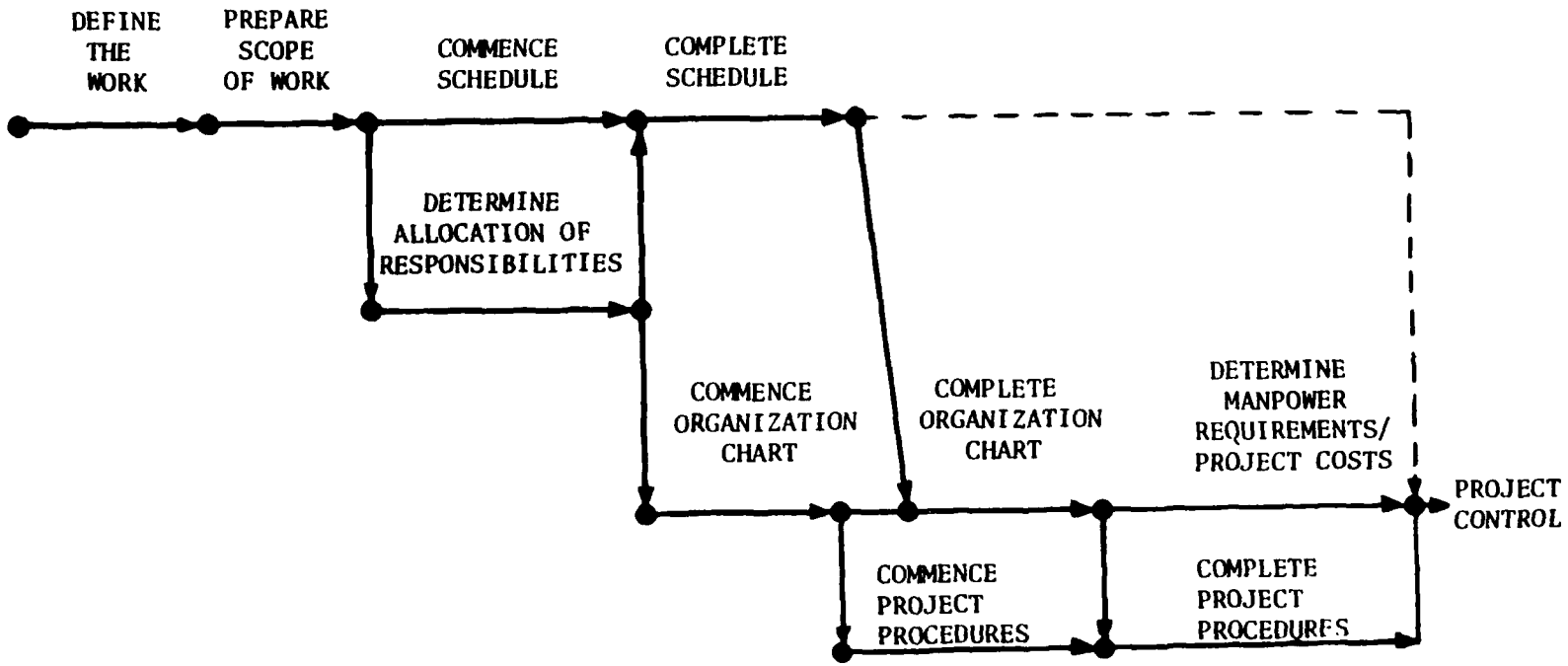


Figure 2.3. Management Process

Source: Dinsmore, Alexander F. and Burgoine, David. "Management Process: Planning and Control," Issues in Engineering, Journal of Professional Activities, Proceedings of the American Society of Civil Engineers, Vol. 107,No. EI1, January 1981. p. 272

more clearly deviations from these goals stand out. Second was that many managers are so focused on immediate problems that they do not have time to focus on the future. Another reason was that some managers lack the patience to engage in detailed planning and goal-setting activities.

In a study of the top 400 construction companies, as ranked by Engineering News Record, Choromokos and McKee (1981) found that 55% of the companies responding to the survey felt that there was a high opportunity in their office/headquarters operation for productivity improvement in planning and scheduling.

As shown by Figure 2.4, Thune and House (1970), in comparing the performance of eighteen matched pairs of medium- to large-sized companies in the food, drug, steel, chemical, and machinery industries, found that those that had a formal planning system outperformed those that did not. They also found that, since the advent of formalized planning, the companies using it had outperformed their prior growth. Although this study was done with strategic planning a parallel could be drawn with the importance of planning during the preconstruction phase by CM firms.

Herold (1972), in an extension of the Thune and House (1970) study, found that for the firms in the drug and chemical industries the formal planners not only continued to outperform the nonplanners but increased their lead over nonplanners in almost all performance measures.

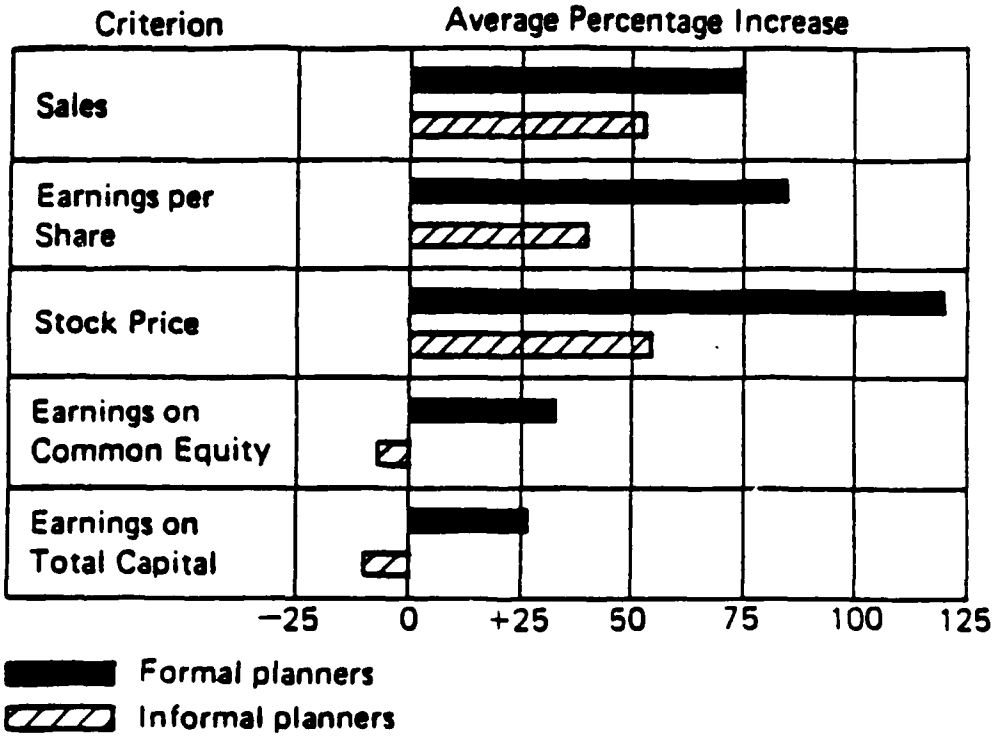


Figure 2.4 Performance of Formal and Informal Planners During the Planning Period

Source: Thune, S.S. and House, R.H. "Where Long-Range Planning Pays Off," Business Horizons, 13: 81-87 (August 1970), p. 83.

In their report on modern management systems in the construction industry the Business Roundtable (1983) found that, on average, it should be possible to achieve a 10% reduction in construction time, for most projects, through better planning. This would result in a 3% saving to the owner, mainly due to his realizing an earlier return on his investment.

Value Engineering

Miles (1961) defined value analysis or value engineering as a philosophy implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills. It is an organized creative approach which has for its purpose the efficient identification of unnecessary cost. Macedo, Dobrow, and O'Rourke (1978) found that the definition of Miles (1961) leads to the conclusion that the process tends to relate product worth to product cost and implies an evaluation of the function performed by the product or its components.

Many researchers, including Halpin and Woodhead (1980), Goldhaber, et al. (1977), Adrian (1978), and Tatum (1979), have indicated that value engineering is a primary reason for the CM process and has a large potential for saving an owner money.

Computerized Estimating

Time and cost are the two key variable that determine the success or failure of a project (Goldhaber, et al.,

1977). At every stage of planning, time and cost are major factors the owner must use to choose between alternatives yet the final cost and time of competition cannot be forecasted accurately until the project is substantially complete (Goldhaber, et al., 1977).

The CM preliminary cost estimate is made without working drawings or detailed specifications and yet this is usually the first dollar figure the owner is exposed to (Adrian, 1981).

A computerized estimating system can store information on quantity data and systematized the accumulation and analysis of detailed cost information from past projects. This greatly increases the ease and accuracy of applying historical experience to the project being estimated (Clough and Sears, 1979).

The Business Roundtable (1982) found that computerized estimating systems are not fully utilized by the construction industry. Many estimates are prepared without using state-of-the-art techniques. They felt that the industry should expand its use of computer aided estimating for efficiency, speed, and cost reduction. Additionally they added that computerized estimating hinges on developing a reliable data base of information.

The GSA, in their prequalification questionnaire for CM firms, asks the CM firm to discuss their method of estimating construction requirements in preconstruction planning. This is one of several questions regarding the CM firm's

Construction Management Control System.

Risk Analysis

It is difficult to justify the construction of any project, private or public, unless a quantitative analysis is made of the cost to benefit ratio. Many times a project has been completed only to have its owner discover it was poorly planned in its economics from its inception (Adrian, 1981).

Erickson and O'Connor (1979) gave a working definition of risk (in construction) as exposure to possible economic loss or gain arising from involvement in the construction process. Providing input to define this risk is seen as a major objective of CM by both the ASCE and the AGC.

The Business Roundtable (1982) has found that many project estimates are prepared by companies without using state-of-the-art techniques for risk analysis. Without the correct input of construction costs and ongoing expected maintenance and repair costs, the validity of any project feasibility study is questionable (Adrian, 1981). Tatum (1979) and the GSA felt that the CM's ability to provide useful input to this risk analysis was an important means of evaluating potential CM performance.

Proposal of Construction and Design Alternatives

All of the various definitions of CM, as noted in Chapter 1, include that the CM should use its experience in the construction field, and on past similar projects, to

propose construction and design alternatives, as required, to the owner. This procedure is central to the entire philosophy of CM of bringing the contractors experience and "know how" into the construction process early on. Halpin and Woodhead (1980), Goldhaber, et al., (1977), Foxhall (1972), and Adrian (1981), among others, have echoed this sentiment.

Team Approach

As described by Adrian (1981) and Goldhaber, et al. (1977), the CM process is a team approach to construction. The ASCE and the AGC both make this distinction also. The team at this level consists of the owner, CM, and A-E but as noted by Fox (1976) there is a need to concentrate responsibility for the constructed product, a demand imposed by buyers of that product. This concept stresses the need to combine and organize disparate disciplines into a coordinated effort.

Fox (1976) continued by saying that being structured as a team is not enough. Team members need to be able to work together and that comes from having worked as a team, from learning by experience all the interactions that ease communications, establish understanding, and convert ideas easily into actions.

Pilcher (1976) noted that it is not only a matter of coincidence that, with the increase in size and complexity of projects, several authors have remarked on the need for a pre-planning group in the organizations to investigate

thoroughly the proposals, design options, budgets and contractual arrangements in order to ensure a viable project and optimized project content.

Noted by Logcher and Levitt (1976) was the fact that the amount of data available from present day MIS systems may well exceed the amount a single project manager can process and use in decision making.

Hypotheses

Based on the literature reviewed, the following hypotheses will be tested.

- Using computerized estimating techniques during preconstruction planning has a positive relationship to effectiveness.
- Value engineering has a positive relationship to effectiveness.
- A team sharing supervision of the entire preconstruction phase of a project has a positive relationship to effectiveness.
- The proposal of construction and design alternative during preconstruction planning by the CM firm has a positive relationship to effectiveness.
- Risk analysis in preconstruction planning has a positive relationship to effectiveness.

Summary

As can be seen from this review of pertinent literature the construction industry is not besieged by an army of researchers. The majority of the reviewed literature on the construction industry came from two sources: Journal of the Construction Diversion of the ASCE and the Proceeding of the CIB-65 Symposium on Organization and Management of Construction held May 19-20, 1976, in Washington, D.C.

The wealth of literature on organizational effectiveness to be found in the business management field allows only a cursory examination in a paper of restricted length.

After an extensive search of the literature available in the construction field concerning planning by CM firms it was found to be impractical to arrive at any hypotheses other than the simple "if-then" form. An intensive study of the statistical analysis of the data should indicate relationships of the "if this and this then this" form.

Listed in Figure 2.5 are the simple hypotheses arrived at as a result of this review.

1. The length of experience a company has with CM contracts has a positive relationship to effectiveness.
2. The size of a CM company has a positive relationship to effectiveness.
3. Exposure of CM managers to sources of information about new management techniques has a positive relationship to effectiveness.
4. Using a network based scheduling system during preconstruction planning has a positive relationship to effectiveness.
5. Being hired as CM prior to the hiring of the A-E has a positive relationship to effectiveness.
6. The CM firm establishing communication procedures for the management team (CM, owner, A-E) has a positive relationship to effectiveness.
7. Project size has no relationship to CM effectiveness.
8. Using computerized estimating techniques during preconstruction planning has a positive relationship to effectiveness.
9. Value engineering has a positive relationship to effectiveness.
10. A team sharing supervision of the entire preconstruction phase of a project has a positive relationship to effectiveness.
11. The proposal of construction and design alternative during preconstruction planning by the CM firm has a positive relationship to effectiveness.
12. Risk analysis in preconstruction planning has a positive relationship to effectiveness.

Figure 2.5. Summary of Working Hypotheses.

CHAPTER 3

METHOD

Overview

This chapter describes the sample chosen for the study. In addition, certain demographic facts about that sample are included and the measures used to describe these characteristics of the research sample are discussed in detail. Also described are the procedures utilized in preparing, mailing, and following up on the survey questionnaire. Finally, the statistical procedures to be used in analyzing the data and the reasoning behind using those particular methods are discussed.

Sample

The sample chosen for this study consisted of those companies who advertise that they provide CM services in the 1982 issue of the Construction Buyers Guide, published by the Builder's Exchange of Detroit, Michigan. These companies were all located in Michigan with the largest percentage located in or near Detroit. The original list contained 92 companies (See Appendix A) but it was presumed that some of those would no longer be in business, no longer be offering CM services, or for some other reason would fail to return the questionnaire.

Descriptive Measures

The measures used to describe the characteristics of the sample fall into four general categories: characteristics of the company, the environment of CM projects which the company undertakes, the planning which the company does in the preconstruction phase, and the experience of the company in meeting owners' requirements, on time and within budget. These measures were investigated through the use of a mail-out questionnaire (See Appendix B).

Organizational Characteristics

In order to characterize the company several different measures were used. Some of these were designed to give an indication of the age of the company, its size and the scope of its activities, the size of its CM contracts, its physical area of operation, and how important CM contracts were to its operations. Another question was asked to discover how the company was organized. In addition to these, several questions were asked to determine how the CM company increases its knowledge of how to manage CM contacts.

Environment of the CM Project

As noted in Chapter 2, construction projects tend to create their own environment and the bigger the project the more this tendency is demonstrated. Two questions were asked to measure this portion of the CM environment. Another of the CM company's environmental concerns is when the firm is hired and the control it has over the establishment

of the communication procedures for the management team composed of the CM, owner, and A.E. Scheduling is an important part of the construction project and the requirement for a network based scheduling by the owner affects the environment in which the CM company functions. The final measure of the project environment to be investigated was whether the owner of the CM project was a public or private organization.

Preconstruction Planning Techniques

Measures of preconstruction planning consist, in part, of questions about how this planning is managed, by an individual or by a team. The use of computer generated schedules and computerized estimating techniques in preconstruction planning was also investigated through the questionnaire. Measures were designed for investigating the amount of formalization in the preconstruction planning and the amount of adherence to the plan once set. The proposal of design and construction alternatives during planning, by the CM, is one area where this form of contracting is supposed to increase the efficiency of the project. Two questions regarding this area were asked. The application of "risk analysis" and "value engineering" during preconstruction planning was measured. Additionally, two questions were asked to determine how often the team concept of project supervision was used in the company.

Experience of the Company in Meeting Owner Goals

Measures in this area were keyed to the needs of the project owner. The owner wants a quality project which is completed on time and within the budget originally set. The CM companies were asked how often their completed CM projects met the owner's original budget, the final pre-bid estimates, the owner's original completion date, and the completion date set in the preconstruction plan. To measure how selective both owners and CM companies were in contracting for jobs, a question was asked about the percentage of jobs actually contracted for after participating in a selection interview. Several questions concerning the financial health of the company were asked in order to measure the validity of CM as an alternate method of construction contracting.

The Questionnaire

The questionnaire was prepared over the period of two months, during which time a continuing search of the available literature defined the final form of the survey instrument. The completed questionnaire (Appendix B) consisted of 52 questions divided into four major sections preceded by a cover letter explaining the questionnaire and the efforts of the researcher to ensure the confidentiality of the respondent companies. Also included in the cover letter was an offer to send a feedback report to companies which desired one.

The four major sections of the questionnaire were (1) questions about company characteristics, (2) questions about the type of CM projects the company undertakes; (3) questions concerning the planning which the company does in the preconstruction phase, and (4) questions about the company's experience in the CM field over the last five years. Section 4 also included three questions about the company's financial performance during the past year. Each question was constructed so that a choice of five possible answers was provided. The only exceptions were the three questions concerning financial performance. The companies were asked to provide the answers to these in the form of a ratio.

After the questionnaire was completed it was pretested by being given to two firms in the Lansing, Michigan area which operated in the CM field. These companies were Clark Construction Company and the Christman Company. The heads of these companies were asked to inspect the questionnaire looking for questions which were unclearly worded or for which the choice of possible answers provided was too limited. No questions of this type were noted.

Survey Distribution and Follow-Up

The survey was conducted through the use of a questionnaire mailed to each of the 92 companies listed in Appendix A, all of which had Michigan addresses. The survey was addressed to the Chief Executive Officer. The survey

package consisted of a questionnaire and a self-addressed, stamped envelope in which to return the completed questionnaire. The original mailing was done on March 1, 1984. A telephone follow-up was scheduled for March 19-23, 1984, in order to remind the companies of the questionnaire and to find out which companies needed to be included for the second mailing. Due to compliance with university regulations concerning the confidentiality of respondents, the questionnaire was constructed so that there was no means of identifying which company had returned the questionnaire. This meant that all of the companies had to be contacted for the follow-up.

Statistical Procedures

The statistical procedures which were used in the analysis of the data are part of the integrated system of computer programs called Statistical Packages for the Social Sciences (SPSS). This is a unified and comprehensive system designed for the analysis of social science data that allows the researcher to perform many different types of data analysis (Statistical Package for the Social Sciences, 1975). Three procedures from the package were used to analyze the data from the questionnaires.

One Way Frequency Distribution

The first procedure to be utilized in the analysis of the data was a frequency distribution. This procedure computes and presents frequency distribution tables for

categorical variables. Categorical variables are those variables classified into a limited number of values or categories (SPSS, 1975). In addition, the procedure provides the mean, standard deviation, and range for each variable, (See Appendix C). These statistics were used to describe the sample.

This procedure also enabled the researcher to detect those variables for which all the responses had the same value, and thus gave no information that was useful for analyses. Performing this procedure first allowed the researcher to check the correctness of the file set-up prior to performing more complex statistical analyses.

Pearson Correlation

The procedure computed Pearson product-moment correlations for pairs of variables. These correlations are known as zero-order correlations because no controls for the influence of other variables are made (See Appendix C). The Pearson correlation coefficient, r, is used to measure the strength of the linear relationship between two interval-level variables. When r is squared, this statistic (r^2) gives the proportion of variance in one variable explained by its linear relationship with the other (SPSS, 1975). Pearson correlations were used to test the two variable hypotheses. For example, if companies that have been in business longer are more likely to complete CM jobs by the owners' original date than the companies which have not been in business as long, the correlation between years in

business and completion on time will be statistically significant. This procedure produced a correlation matrix which showed the strength of relationship each variable had with every other variable. Also shown was the level of statistical significance for each relationship.

Tests of statistical significance, which are automatically performed on each correlation coefficient by the SPSS program, determine the probablility that each correlation coefficient observed in the sample is "sufficiently" large to warrant concluding that a linear relationship actually does exist between the correlated variables examined. To test the null hypothesis that the correlation coefficient, r, equals zero, the following formula is computed using sample values for r, r^2, and n:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

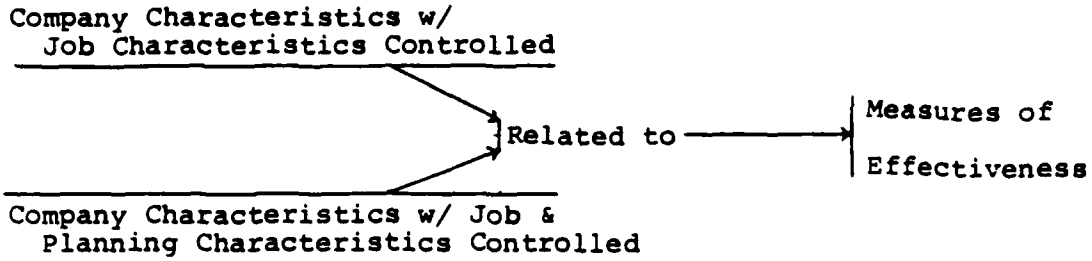
The resulting t-value is compared to a standard table, to determine whether the probability (P) is "sufficiently" small that an r as large as the one obtained would be obtained from a random sample of size n drawn from a population whose r is actually zero. By convention, the criterion for "sufficiently" small is a probability of .05 or less. A level of significance of $p \leq .01$, for example, indicates that there is only one chance (or fewer) in 100 of obtaining a correlation coefficient as large as the one found in the sample by pure chance. The alternative, which we infer, is that there actually is a non-zero, linear, relationship

between the two variables. Typically, statistically significant results from a sample are generalized to a population that has the same characteristics as the sample. In this case, to the extent that the sample represents all Michigan and other U.S. CM firms, the results would be expected among those firms (Cohen & Cohen, 1983).

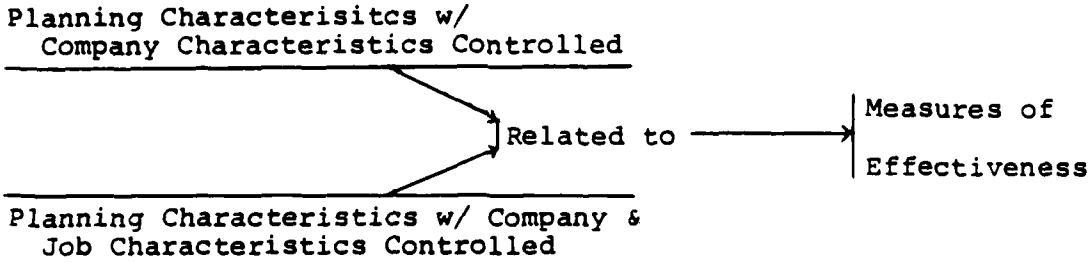
The correlation matrix was examined to determine which pairs of variables had a strong relationship and, as a consequence, explained a large amount of the variance in each other. Since r and r^2 are symmetric measures of association, it does not matter which variable is considered to be predicting the other (SPSS, 1975).

Partial Correlation

This procedure provided the researcher with a single measure of association which described the relationship between two variables while holding constant (controlling) one or more additional variables. Partial correlation allows the removal of the effect of the control variable from the relationship between the independent and dependent variables (SPSS, 1975) (See Appendix C). This method of statistical analysis was used to test for variables which had interrelated effects. As shown by Figure 3.1.A, a pair of partial correlation coefficients was obtained for each organizational characteristic indicating the strength of its relationship to the measures of effectiveness. The first partial coefficient obtained was with job characteristics controlled. The second partial was with both job and



A. Company characteristics related to measures of effectiveness.



B. Planning Characteristics related to measures of effectiveness.

Figure 3.1 Partial Correlation Procedure

planning characteristics controlled. A t-test was then performed to determine if there was a significant difference between the simple correlation coefficient and the partials obtained when job and job/planning characteristics were controlled. If a significant difference was shown by the second partial (job/planning characteristics controlled) and not by the first partial (job characteristics controlled) this indicated that some combination of planning characteristics was affecting the relationship of that characteristic to the measure of effectiveness.

The same procedure was followed for the relationship of the planning characteristics to the measures of effectiveness. Figure 3.1.B shows that first organizational characteristics were controlled and then organizational/job characteristics. In this case, if the first partial was significantly different it indicated that some combination of organizational characteristics was affecting the relationship of that planning characteristic to the measure of effectiveness. If the second partial was significantly different it indicated that the combined effects of organizational and job characteristics were affecting the relationship of the planning characteristic.

In both of the partial correlation procedures discussed above, if the coefficients (simple and partials) stayed relatively the same, this indicated that controlling the different characteristics were no difference. Whatever was

being controlled had no impact on the underlying relationship shown in the simple correlations.

Summary

This chapter described how the sample was chosen and detailed the procedures followed in preparing, mailing, and following up on the questionnaire. Also described were the four major sections of the questionnaire: company characteristics, job characteristics, planning techniques, and measures of effectiveness. The reasons and methods for utilizing the three statistical procedures, frequency, Pearson correlation, and partial correlation were discussed.

CHAPTER 4

RESULTS

Overview

This chapter provides a description of the mailing and follow-up procedures which were employed to attain the best questionnaire return rate. Additionally, the chapter describes the typical company responding to the questionnaire utilizing company, project, planning characteristics, and company experience with CM projects to do so.

The results of the research (simple correlations) concerning organization characteristics and job characteristics related to planning are set forth, delineated by company experience, size, information sources, and organization. The results of the tests of the simple hypotheses are also provided.

Results of the partial correlation analysis, provided by this chapter, include the relationships of organizational characteristics to measures of effectiveness when the effects of job characteristics are controlled (removed) and when both job and planning characteristics are controlled. Also included are the relationship of planning characteristics to measures of effectiveness when organizational characteristics are controlled and when both company and job characteristics are controlled.

Survey Response

Of the original 92 questionnaires which were mailed, seven (7.6%) were returned by the Postal Service as undeliverable. Two and one-half weeks after the original mailing, on March 1, 1984, 18 completed questionnaires had been received. From March 19-23, 1984, a telephone follow-up was conducted in which 60 of the 85 remaining companies were contacted. Of the 60 companies, 11 told the researcher that they either did not do CM or that they had not had a CM contract in the past three or four years and did not feel competent to answer the questionnaire. This meant that the number of companies who could possibly respond was 74. Of the 60 companies contacted 15 requested an additional questionnaire and these were mailed. By April 6, 1984, the total number of completed questionnaires received was 32. This represented 35% of the original mailing and 43% of those companies who could possibly respond.

Description of the Typical Company

Organizational Characteristics

As indicated by Table 4.1 the typical company responding to the survey had been doing business in the construction industry for 16 to 20 years (>20 years, 65.6%)[2], had been offering CM services for seven to nine years (>12

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[2]The parentheses denotes the most frequent response to that question and the percentage of respondents (N/32) who gave that response. This does not always correspond to the mean for that question. See Appendix E for all responses.

Table 4.1 Organizational Characteristics: Means, Standard Deviations (S.D.), and Ranges

Characteristic	Mean[a]	S.D.	Range Low	Range High
Years in business	4.22	1.18	6-10 yrs	>20 yrs
Years in CM	3.45	1.48	1-3 yrs	>12 yrs
Years with in-house design capability	1.69	1.40	0 yrs	>15 yrs
Number of branch offices	1.59	1.01	0	>15
Number of full time employees	1.41	1.10	<50	>350
Number of CM contracts (last five years)	1.78	1.18	1-10	>40
Value of CM contracts (last five years)	2.94	1.50	<$2.5 mill	>$90 mill
Percent of individuals, employed during pre-construction, who are permanent employees	3.97	1.47	<20%	80-100%
Volume of CM work with present work force	3.47	1.30	$1-10 mill	>$30 mill
Percent of in-place volume due to CM contracts (last five years)	2.56	1.44	0-20%	81-100%
Useful sources of CM contract management information:				
- Professional Journals	2.53	.80	Not at all useful	Very useful
- In-house seminars	2.38	.91	Not at all useful	< Very useful
- Seminars by professionals	2.94	1.34	Not at all useful	Very useful
- Manager's own experience	4.47	.76	< Very useful	Very useful
Company organization	3.34	1.21	Line	Staff

[a] The mean given is based on the number (1-5) which corresponds to possible answers in the questionnaire. For an explanation of possible answers, see the questionnaire (Appendix B).

years, 37.5%), and did not have any in-house design capability (none, 75%). This typical company had no branch offices (no branch offices, 59.4%) and employed, full time, fewer than 50 people (<50 employees, 84.4%). In addition, this company had completed ten or fewer CM contracts (1-10 CM contracts, 53.1%) with a total value of $30 million or less ($2.5-30 million, 28.1%; >$90 million, 28.1%) in the last five years.

The typical survey respondent could do $10-20 million of CM work with his present workforce and of the people employed during the preconstruction phase, 40%-60% were permanent employees (80-100%, 59.4%). This company had generated 21%-40% of its in-place volume over the last five years from CM jobs.

As a source of information for managing the company's CM contracts more efficiently, the manager's own experience was by far the most important (very useful, 62.5%). Interacting with design firms (somewhat useful, 46.9%) was found to be somewhat useful as an information source while seminars by professionals (somewhat useful, 28.1%), professional journals (somewhat useful, 53.1%), and in-house seminars (somewhat useful, 46.9%) were described as the least useful. This typical company had an organizational structure which is a combination line and staff structure (combination, 50.0%).

Environmental Characteristics

The smallest CM project completed in the last five years (<$500K, 56.3%) was less than $500K while the largest ($1.0-$10 million, 46.9%) was worth between $1 million and $10 million.

As shown by Table 4.2, in a CM project the typical company had the major role in establishing the team communication procedures (always, 37.5%) 50% of the time, while on 33% of the projects a network based scheduling system was required by the owner (one-third of time, 31.3%). Only 33% of the time was the company hired as CM before the A-E was hired (one-third of time, 46.9%) and 50%-75% of the company's CM contracts, over the last five years, were done for private owners (75-100%, 59.4%).

Planning Characteristics

From reviewing Table 4.3 one can see that the typical company was more likely to use one individual to supervise the preconstruction planning than it was to use a team for supervision. It used computer generated schedules during preconstruction planning less than 30% of the time, and used computerized estimating techniques on almost no CM jobs.

Value engineering techniques were incorporated into planning on 30% - 60% of all CM jobs but formalized methods of "risk analysis" were used only rarely.

The steps used in planning a CM job rarely varied with the size of the job, while 30% to 60% of the projects had a budget, during the conceptual stage, for completing the

Table 4.2 Environmental Characteristics: Means, Standard Deviations (S.D), and Ranges

Characteristic	Mean[a]	S.D.	Range	
			Low	High
Value of smallest CM project completed in last five years	1.63	.83	<$500K	>$10 mill
Value of largest CM project completed in last five years	2.84	1.42	<$1 mill	>$30 mill
Part of time with major role in establishing team communication procedures	3.53	1.32	Never	Always
Portion of CM contracts with network based scheduling system an owner requirement	2.75	1.34	None	All
Part of time hired as CM prior to hiring of A-E	2.44	1.08	Never	Always
Percent of CM jobs done for private owners	4.13	1.29	0%	75-100%

[a] The mean given is based on the number (1-5) which corresponds to possible answers in the questionnaire. For an explanation of possible answers, see the questionnaire (Appendix B).

Table 4.3 Planning Characteristics: Means, Standard Deviations (S.D.), and Ranges

Characteristic	Mean[a]	S.D.	Range	
			Low	High
One supervisor for preconstruction	3.31	1.23	Never	Always
Team supervision of preconstruction	2.94	1.27	Never	Always
Percent of time computer generated schedules used in planning	2.16	1.35	Never	Always
Percent of CM jobs incorporating "Value Engineering" into planning	3.53	1.30	None	All
CM jobs using computer estimating techniques during planning	1.88	1.39	No CM jobs	All CM jobs
Planning steps vary with job value	2.75	1.14	Never	Always
Percent of CM jobs with dates for completing design phase set during conceptual planning	3.63	1.31	None	All
Updating dates in preconstruction plan	4.19	.93	Semi-weekly	Monthly or less often
Application of "Risk Analysis"	2.50	1.39	Never	Always
Proposal of design alternatives	3.84	.68	Sometimes	Always
Proposal of construction alternatives	3.78	.83	Sometimes	Always
Decisions affecting planning made:				
- By owner	2.56	.80	None	All
- By CM	2.78	.91	1-30%	All
- By A-E	2.72	1.03	None	All

[a] The mean given is based on the number (1-5) which corresponds to possible answers in the questionnaire. For an explanation of possible answers, see the questionnaire (Appendix B).

design phase. Additionally, the typical company updated the preconstruction plan on a semi-monthly basis.

The company sometimes proposed construction (sometimes, 46.9%) or design alternatives (usually, 53.1%) during the preconstruction phase. The decisions affecting planning during the preconstruction phase were made as often by all three members of the CM team, owner, CM, and A-E.

Experience of the Company in Meeting Owner Goals

The company had met the needs of the owner, as defined in the questionnaire, less than 60% of the time on CM contracts over the last five years (Table 4.4). Fewer than 60% of the CM jobs had a final cost equal to or less than the owner's original budget (60-90%, 50%) or the final pre-bid estimate (60-90%, 50%). In addition, less than 60% of the CM jobs were completed by the owner's original completion date (60-90%, 62.5%) or the date established during the preconstruction phase planning (60-90%, 65.6%).

The company actually contracts for less than 30% of the CM jobs for which they participate in a selection interview by the owner (1-30%, 40.6%). The company's CM portion is believed to be improving more slowly than that of their competition (same, 31.3%).

Organizational Characteristics Related to Planning

For clarity of discussion, the results of the research concerning the organizational characteristics will be arranged as they were in Chapter 2. The order of discussion

Table 4.4 Measures of Effectiveness: Means, Standard Deviations (S.D), and Ranges

Measure	Mean[a]	S.D.	Range	
			Low	High
Percent of CM jobs with final cost ≤ owners original budget	3.69	.93	None	All
Percent of CM jobs with final cost ≤ final pre-bid estimate	3.72	1.14	None	All
Percent of CM jobs completed by owner's original completion date	3.47	.92	None	All
Percent of jobs CM completed by date established during pre-construction planning	3.72	.68	1-30%	All

[a] The mean given is based on the number (1-5) which corresponds to possible answers in the questionnaire. For an explanation of possible answers, see the questionnaire (Appendix B).

is company experience, size, information sources, and organization.

Experience

The simple correlation analysis displayed in Table 4.5 indicates that the longer a firm had been in the construction business (YRSNBUS) the less likely it was to employ a formalized method of "risk analysis" (RISKANL) during the conceptual stage of a CM project (-.30*).[3] In addition, the A-E was less likely to make decisions affecting planning (DECBYAE) during the preconstruction phase (-.43**). Owners were more likely to make decisions affecting planning (DECBYOWN) in the preconstruction phase for more established companies (.38* and .75***).

The number of years a CM company has had an in-house design capability (YRSNHSE) was positively related to its having the major role in establishing the communication procedures (COMMO) for the management team (.44**).

The number of CM contracts which a company had completed in the last five years (NUMCMCTS) was positively related to the use of computer generated schedules (CMPPLN) to assist in planning (DECBYOWN, .41**) and to the percent of decisions affecting planning made by the owner (.75***). Decisions affecting planning made by the CM (DECBYCM, -.47**) and the A-E (DECBYAE, -.32*) were inversely related

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[3]The figure in parenthesis is the Pearson correlation coefficient with *p. $\leq$ .05, **p. $\leq$ .01, ***p. $\leq$ .001.

to the number of CM contracts a company had completed in the last five years.

Organizational Size

As indicated by Table 4.5, the use of computer generated schedules (CMPPLN) to assist in preconstruction planning (.50**) and the percentage of decisions, affecting planning (DECBYOWN), made by the owner (.40**) both showed a positive relationship to the number of branches (NUMBRNCH) which a CM company has. The percentage of decisions (DECBYAE), affecting planning made by the A-E (-30*) showed a negative, or inverse, relationship to the number of branches a CM company has.

The number of full time employees (NUMEMPFL), excluding trades, which the CM company had, displayed a positive relationship to both having the major role in establishing team communication procedures (COMMO, .36*) and the percent of time a team supervises the entire preconstruction phase (TMSUPER, .32*).

Incorporating "value engineering" into preconstruction planning (VALENG) had a positive relationship to the value of new construction done, under CM contracts, in the last five years (VALCMCTS, .35*). The use of computer estimating techniques (CMPEST) in planning also had a positive relationship (.37*) to the value of new construction. The percentage of decisions, made by the owner (DECBYOWN), affecting planning had a positive relationship (.33*) to value of new construction while the percent of decisions

Table 4.5 Correlation Coefficients of Organizational Characteristics Related to Planning Characteristics

Organizational Characteristic	Planning Characteristic														
	COMMO	ONESUPER	TMSUPER	CMPPLN	VALENG	CMPEST	PLNVSSIZ	SETDTDES	PLNUPDT	RISKANL	DESGNALT	CONSTALT	DECBYOWN	DECBYCM	DECBYAE
- Experience															
YRSNBUS	[a]									-.30*[b]					-.43**
YRSNCM															
YRSNHSE	.44**			.41**									.75***	-.47**	
NUMCMCTS															-.32.**
INPLVOL															
- Size															
NUMBRNCH				.50**									.40**		-.30*
NUMEMPFL	.36*		.32*												
VALCMCTS					.35*	.37*							.33*	-.32*	
PRECONEM	.30*							.36*	.50**				.34*		
VOLWKPRS				.35*		.43**			.32*				.39*		
- Information															
PROFJOUR										.33*					
SEMNHOUS		-.34*													
SEMBYPRO		-.40*	.34*				-.35*								
INTERACT		-.35*	.39*				-.41*								
MANGREXP	.48**					-.40*		.34*	.42**		.40*			.34*	
- Organization															
COORGAN					.42**				.34*		-.45**	-.47**		-.46**	

[a] All correlation coefficients not appearing in the body of the table had a p. greater than .05. See Appendix F for the complete matrix.

[b] *p.=< .05, **p.=< .01, ***p.=< .001.

made by the CM (DECBYCM) had an inverse relationship (-.32*).

The percentage of employees used by the CM firm during preconstruction planning (PRECONEM), who are permanent, had a positive relationship to having the major role in establishing communication procedures (COMMO, .30*), setting dates, during the conceptual stage, for completing the design phase (SETDTDES, .36*), and updating those dates set for the firm's preconstruction plan (PLNUPDT, .50**). Additionally, it had a positive relationship to percent of decisions made by the owner which affect planning (DECBYOWN, .34*).

The volume of CM work which the company could handle with its present workforce (VOLWKPRS) was positively related to the use of computer generated schedules for planning (CMPPLN, .35*) and to the use of computer estimation techniques during planning (CMPEST, .43**). Updating those dates set for the firm's preconstruction plan (PLNUPDT, .32*) and the percentage of decisions made by the owner which affect planning (DECBYOWN, .39*) were also positively related.

Information

The use of in-house seminars (SEMNHOUS), seminars given by professionals (SEMBYPRO), and interaction with design firms (INTERACT) as a source of information to manage CM contracts (Table 4.5) had an inverse relationship to one

supervisor for the entire preconstruction phase (-.34*, -.40*, and -.35* respectively).

Seminars by professionals (.34*) and interaction with design firms (.39*) as sources of management information had a positive relationship to using a team to supervise the preconstruction phase (TMSUPER). These two also had an inverse relationship to planning which varies with the size of the project (PLNVSSIZ).

The manager's own experience (MANGREXP), used as a source of management information, had a negative relationship to the use of computer estimating techniques during planning (-.40*). The manager's experience was positively related to establishing communication procedures for the management team (COMMO, .48**), setting dates, during the conceptual phase, for completing the design phase (SETDTDES, .34*), and for updating those dates set (PLNUPDT, .42**). In addition, the manager's experience was related in a positive direction to the proposal of design alternatives (MANGREXP, .40*) and decisions made by the CM which affect planning (DECBYCM, .34*).

Organizational Form

The manner in which the CM company is organized (COORGAN), line structure to staff structure, was found to have a positive relationship to the use of "value engineering" (VALENG, .42**) and to updating those dates set during preconstruction planning (PLNUPDT, .34*). This organizational attribute showed an inverse relationship to both the

proposal of design and construction alternatives (DESGNALT, -.40*** and CONSTALT, -47***) and to the percent of decisions, affecting planning, made by the CM (DECBYCM, -.46**).

Organizational Characteristics Related to Environmental Characteristics

Experience

The years a company has had an in-house design capability had a negative relationship (YRSNHSE, -.30*) to the value of the smallest CM project done in the last five years (VALSMPRJ) but had a positive relationship (.44**) to the company being hired prior to the A-E (HIREBFAE). The number of CM contracts completed in the last five year (NUMCMCTS) and the percent of the company's in-place volume due to CM contracts (INPLUOL) had a positive relationship to the value of the largest CM project completed (VALLGPRJ) in the last five years (.50** and .44** respectively) as shown by Table 4.6.

Organizational Size

The number of branch offices (NUMBRNCH, .54***), the number of full time employees (NUMEMPFL, .56***), the value of CM contracts over the last five years (VALCMCTS, .92***), and the volume (dollars) of CM work with their present workforce (VOLWKPRS, .75***) all had a positive relationship to the value of the largest CM project done in the last five years (VALLGPRJ).

Table 4.6 Correlation Coefficients of Organizational Characteristics Related to Environmental Characteristics

Organizational Characteristic	Environmental Characteristic VALSMPRJ	VALLGPRJ	NTWRKSYS	HIREBFAE	PVTJOBS
-Experience					
YRSNBUS	a				
YRSNCM					
YRSNHSE	-.30*[b]			.44**	
NUMCMCTS		.50**			
INPLVOL		.44**			
-Size					
NUMBRNCH		.54**			-.38*
NUMEMPFL		.56**		.39*	
VALCMCTS		.92***	.40*		-.51***
PRECONEM					.31*
VOLWKPRS		.75***	.46**		
-Information					
PROFJOUR					
SEMNHOUS					
SEMBYPRO		-.34*			
INTERACT					.32*
MANGREXP		-.35*			.46**
-Organization					
COORGAN		.54***			-.40*

[a]All correlation coefficients not appearing in the body of the table had a p. greater than .05. See Appendix F for the complete matrix.

[b]*p.=<.05, **p.=<.01, ***p.=<.001

Value of CM contracts done in the last five years and volume of CM work with their present work were both related positively (.40* and .46**) to the owner requiring a network based scheduling system (NTWRKSYS).

The number of full time employees was related positively to being hired prior to the A-E (HIREBFAE, .39*). The percentage of private owner CM projects (PVTJOBS) done had a negative relationship to both the number of branch offices (NUMBRNCH, -.38*) and the value of CM contracts completed over the last five years (VALCMCTS, -.51***) but had a positive relationship (.31*) to the number of permanent employees used during the preconstruction phase (PRECONEM).

Information

The use, for a source of information for managing CM contracts, of seminars given by professionals (SEMBYPRO, -.34*) and the manager's own experience (MANGREXP, -.35*) was inversely related to the value of the largest project completed in the last five years (VALLGPRJ). Using interaction with design firms (INTERACT) and the manager's experience (MANGREXP) as a source of CM management information both had a positive relationship to the percentage of jobs done for private owners (PVTJOBS) (.32* and .46** respectively).

Organizational Form

How a company is organized (COORGAN), line structure to staff structure, was related positively to the value of the

largest CM job completed in the last five years (VALLGPRJ, .54***) but was inversely related (-.40*) to the percentage of jobs done for private owners.

Environmental Characteristics Related to Planning Characteristics

Project Size

As shown in Table 4.7, the value of the smallest project done (VALSMPRJ) was inversely related to the use of one supervisor during preconstruction planning (ONESUPER, -.45**) and to the percentage of decisions affecting planning made by the owner (DECBYOWN, -54***). The smallest project value also had a positive relationship to both the use of the team to supervise preconstruction planning (TMSUPER, .34*) and to the use of "value engineering" (VALENG, .37*). (See Table 4.7)

The value of the largest project (VALLGPRJ) had a negative relationship to the percentage of decisions, affecting planning, made by the CM (DECBYCM, -.38*) but was positively related to the use of "value engineering" (.36*) and the use of computer estimating techniques during preconstruction planning (CMPEST, .32*).

Contracting Sequence

Being hired as CM prior to the hiring of the A-E (HIREBFAE) was positively related to setting dates for the completion of the design phase during conceptual planning (SETDTDES, .35*).

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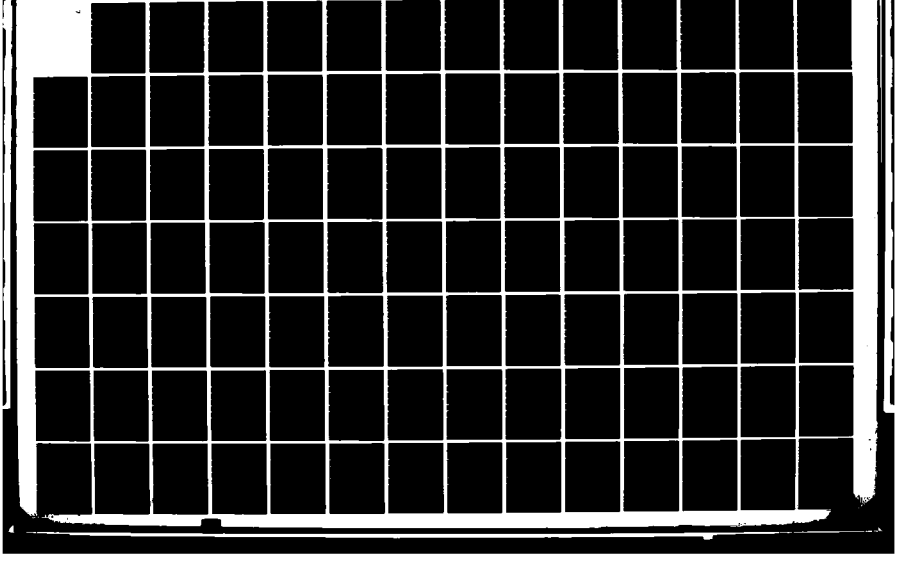

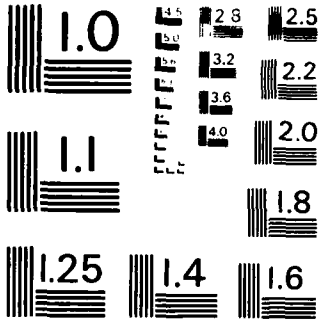

Table 4.7 Correlation Coefficients of Environmental Characteristics Related to Planning Characteristics

Environmental Characteristic	Planning Characteristic														
	COMMO	ONESUPER	TWSUPER	CMPPLN	VALENG	CMPEST	PLNVSSIZ	SETDTDES	PLNUPDT	RISKANL	DESGNALT	CONSTALT	DECBYOWN	DECBYCM	DECBYAE
VALSMPRJ	[a]	-.45**[b]	.34*										-.54***		
VALLGPRJ					.36*	.32*								-.38*	
NTWRKSYS		.30*	-.33*							.38*	-.36*	-.34*		-.39*	
HIREBFAE								.35*							
PVTJOBS						-.37*				-.34*	.36*			.63***	-.36*

[a] All correlation coefficients not appearing in the body of this table had a p. greater than .05. See Appendix F for the complete matrix.

[b] *p.=<.05, **p.=<.01, ***p.=<.001

Private Owners

The percentage of jobs done for private (PVTJOBS), as opposed to public, owners was negatively related to the used of computer estimating techniques (CMPEST, -.37*), the use of "risk analysis" techniques (RISKANL, -.34*), and to the percentage of decisions, affecting planning, made by the A-E (DECBYAE, -.36*). Percentage of jobs done for private owners showed a positive relationship to the proposal of design alternatives (DESGNALT, .36*).

Network Based Scheduling Systems

Required by the owner as a requirement and not an option, the use of a network based scheduling system for CM contracts (NTWRKSYS) had a positive relationship to using one supervisor for preconstruction planning (ONESUPER, .30*), the use of computer estimating techniques (CMPEST, .61***), setting dates for the completion of the design phase (SETDTDES, .31*), and to the use of "risk analysis" (RISKANL, .38*).

Using a team to supervise preconstruction planning (TMSUPER, -.33*) and the percentage of decisions affecting planning, made by the CM, (DECBYCM, -.39*) both had a negative relationship to this variable. Additionally, the proposal of design (DESGNALT, -.36*) and construction (CONSTALT, -.34*) alternatives was also inversely related.

Measures of Effectiveness (Interrelationships)

The four measures of effectiveness, final cost equal to or less than owner's original budget (CSTOWNBG), final cost equal or less than final pre-bid estimate (CSTPREBD), job completed on or before owner's original date (JOBOWNDT), and job completed on or before the date set during preconstruction planning (JOBPREDT) could be combined into two different groups.

The first of these groups could be visualized as dollars and dates. CSTOWNBG and CSTPREBD (see Table 4.8) were both most directly linked with meeting a cost and had an r of .76***. JOBOWNDT and JOBPREDT were most directly linked with meeting calendar dates and had an r of .48**.

A second grouping concept would be those measures of effectiveness most directly concerned with goals internal to the CM company and those concerned most directly with goals more external to the company. CSTPREBD and JOBPREDT appeared to be involved with internally set goals and had an r of .47**. CSTOWNBG and JOBOWNDT appeared to be linked more to goals set by the owner and had an r of .44**.

Cutting across the arbitrary groups, costs-dates and internal-external goals, was the relationship between JOBPREDT and CSTOWNBG (.57***).

Table 4.8 Correlation Coefficients Between Dependent Variables

Dependent Variable	CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT
CSTOWNBG	1.00	.76***[a]	.44**	.57***
CSTPREBD	.76***	1.00	[b]	.47**
JOBOWNDT	.44**		1.00	.48**
JOBPREDT	.57***	.47**	.48**	1.00

[a] *p.=< .05, **p.=< .01,***p.=< .001

[b] All correlation coefficients not appearing in the body of the table had a p. greater than .05. See Appendix F for the complete matrix.

Simple Hypotheses

Hypothesis No. 1

The length of experience which a company had with CM contracts was related positively to the percent of completed CM jobs with a final cost equal to or less than the owner's original budget (.48**). Length of CM experience was also positively related to the percent of completed CM jobs with a final cost equal to or less than the final pre-bid estimate (.50**). (See Table 4.9) Years in business was unrelated to the four measures of effectiveness.

Hypothesis No. 2

The size of a CM company (variable NUMEMPFL) was positively related to the percent of CM jobs completed by the owner's original completion date (.31*). The percentage of permanent employees utilized during preconstruction planning was positively related to all effectiveness variables: final cost equal to or less than owner's original budget, final cost equal to or less than final pre-bid estimate, job completed on or before owner's original date, and job completed on or before the date set during preconstruction planning.

Hypothesis No. 3

Exposure of CM managers to sources of information about new management techniques had one facet that was inversely related to completing the job by the owner's original date. That was the use of professional journals (-.39*). No other

Table 4.9 Correlation Coefficients of Simple Hypotheses Characteristics Related to CM Effectiveness

Hypothesis Characteristic	Measures of Effectiveness CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT
- Hypothesis #1				
YRSNCM	.48**[a]	.50**	[b]	
- Hypothesis #2				
NUMBRNCH				
NUMEMPFL			.31**	
VALCMCTS				
PRECONEM	.53**	.38**	.56**	.57**
VOLWKPRS				.30*
- Hypothesis #3				
PROFJOUR			-.39*	
SEMNHOUS				
SEMBYPRO				
INTERACT				
- Hypothesis #4				
NTWRKSYS				
- Hypothesis #5				
HIREBFAE			.44**	.30*
- Hypothesis #6				
COMMO		.32*		.53***
- Hypothesis #7				
VALSMPRJ		.33*		
VALLGPRJ			.33*	
- Hypothesis #8				
CMPEST				
- Hypothesis #9				
VALENG				
- Hypothesis #10				
TMSUPER			.36*	.39*

[a] *p.=<.05, **p.=<.01, ***p.=<.001

[b] All correlation coefficients not appearing in the body of the the table had a p. greater than .05. See Appendix F for the complete matrix.

Table 4.9 (cont'd)

Hypothesis Characteristic	Measures of Effectiveness CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT
- Hypothesis #11				
DESGNALT	.53***	.57***		.46**
CONSTALT	.41**	.41**		.34**
- Hypothesis #12				
RISKANL				

source of information was significantly related to effectiveness.

Hypothesis No. 4

The use of a network based scheduling system, as a requirement of the owner, showed no significant relationship to any effectiveness variable.

Hypothesis No. 5

Being hired as CM prior to the hiring of the A-E was positively related to meeting completion dates. The percent of CM jobs completed by the owner's original date had a relationship of .44** and the percent of CM jobs completed by the date established during preconstruction planning had a relationship of .30*.

Hypothesis No. 6

Having the major role in establishing the team communication procedures was positively related to the percent of completed CM jobs with a final cost equal to or less than the final pre-bid estimates (.32*). It also had a positive relationship to the percent of CM jobs completed by the date established during preconstruction planning (.53***).

Hypothesis No. 7

The size of a CM project had a positive relationship with two effectiveness variables. The value of the smallest project completed in the last five years was related to the percent of completed CM jobs with a final cost equal to or

less than the final pre-bid estimate (.33*) while the value of the largest job was related to the percent of CM jobs completed by the owner's original completion date (.33*).

Hypotheses No. 8 & 9

The use of the computer estimating techniques and the use of "value engineering" showed no significant relationship to any effectiveness variable (See Appendix E).

Hypothesis No. 10

The use of a team to supervise the entire preconstruction phase of a project was related to percent of CM jobs completed by the owner's original completion date (.36*). It was also related positively to the percent of CM jobs completed by the date established during preconstruction planning (.39*).

Hypothesis No. 11

The only effectiveness variable to which the proposal of design and construction alternatives was not related, at a significant level, was the percent of CM jobs completed by the owner's original completion date. See Table 4.8 for the strength of those relationships.

Hypothesis No. 12

The use of a formalized method of "risk analysis" showed no significant relationship to any effectiveness variable.

Results of Partial Correlation

Relationship of Organizational Characteristics to Meeting Owner Goals

Final Cost Equal To or Less Than Owner's Original Budget

As indicated in Table 4.10, the value of CM contracts completed in the last five years (VALCMCTS) showed a significant difference (t = 2.59) in its relationship to final cost equal to or less than the owner's original budget when the effects of both job and planning characteristics were removed from the relation (controlled). This was an inverse relationship (-.54*).

Table 4.10 also shows that the significant r of both percent of preconstruction phase employees who are permanent (PRECONEM) and the use of the manager's own experience as a source of CM contract management information (MANGREXP) stayed relatively equal regardless of which factors were controlled in their relationship with final cost equal to or less than the owner's original budget. These were both positive relationships.

Final Cost Equal To or Less Than Final Pre-Bid Estimate

The years a company has been in the construction industry (YRSNBUS) showed a significant difference (t = 2.29) in its relationship, a negative relationship (-.60*), to final cost equal to or less than the final pre-bid estimate. This was true when the effects of both job and planning characteristics were controlled (Table 4.10).

Table 4.10 Organizational Characteristics Related to Measures of Effectiveness: Correlation Coefficients and t-Tests

Organizational Characteristic	Measures of Effectiveness: CSTOMNBG SIMPLE[a]	PARTIAL I[b]	PARTIAL II[c]	t I[d]	t II[e]	CSTPREBD SIMPLE	PARTIAL I	PARTIAL II	t I	t II
YRSNBUS	-.02	-.06	-.20	.20	.58	-.02	-.12	-.60*	.49	2.29
YRSNCM	.48**[f]	.52**	.40	.23	.28	.50**	.52**	.14	.11	1.15
YRSNHSE	-.03	-.15	-.04	.59	.03	-.14	-.27	-.53*	.66	1.45
NUMBRNCH	.07	.09	.22	.10	.49	.04	.17	.20	.65	.52
NUMEMPFL	-.12	-.35	-.44	1.20	1.13	-.14	-.30	-.37	.82	.78
NUMCNCTS	.23	.32*	.52*	.47	1.07	.22	.40*	.20	.96	.06
VALCNCTS	.15	.22	-.54*	.35	2.59[g]	.12	.19	.13	.35	.03
PRECONEM	.53***	.50**	.62*	.17	.36	.38*	.26	-.06	.61	1.39
VOLWKPRS	.26	.28	.38	.10	.41	.24	.17	.37	.35	.44
INPLVOL	.14	.10	-.40	.20	1.86	.08	.02	-.25	.29	1.08
PROFJOUR	-.12	-.14	-.60*	.10	1.90	-.04	-.11	-.19	.35	.48
SEMNHOUS	-.20	-.21	-.62*	.05	1.69	-.05	-.09	-.06	.20	.03
SEMBYPRO	-.15	-.11	-.43	.20	.98	-.14	-.17	-.59*	.15	1.76
INTERACT	-.14	-.30	-.60*	.82	1.82	-.08	-.42*	-.56*	1.84	1.83
MANGREXP	.47**	.50**	.57*	.17	.38	.42**	.35*	.15	.37	.86
COORGAN	-.33*	-.48**	-.63*	.84	1.22	-.21	-.38*	-.26	.90	.16

[a] Simple correlation coefficients

[b] Partial correlation coefficients (controlling for environmental characteristics)

[c] Partial correlation coefficients (controlling for environmental and planning characteristics)

[d] t-value for Simple and Partial I

[e] t-value for Simple and Partial II

[f] *p.=< .05, **=< .01, ***p.=< .001

[g] Underlined t-values are significant at .05 level

Table 4.10 (cont'd)

Organizational Characteristic	JOBCMNDT SIMPLE	PARTIAL I	PARTIAL II	t I	t II	JOBPREDT SIMPLE	PARTIAL I	PARTIAL II	t I	t II
	Measures of Effectiveness									
YRSNBUS	.11	.08	.07	.15	.13	.08	-.03	-.11	.54	.60
YRSNCM	.14	.23	.11	.45	.10	.23	.26	.14	.15	.29
YRSNHSE	.22	.05	.23	.83	.03	.21	-.09	.33	1.48	.40
NUMBRNCH	.14	.06	.17	.39	.10	.20	.17	.35	.15	.51
NUMEMPFL	.31*	.07	-.44	1.18	2.64	.29	-.01	-.45	1.47	2.62
NUMCNCTS	.25	.31	.43	.31	.63	.20	.18	.72**	.10	2.37
VALCNCTS	.26	-.04	-.11	1.47	1.18	.17	.07	-.19	.49	1.16
PRECONEM	.56***	.58***	.66**	.12	.42	.57***	.46**	.62*	.61	.20
VOLWKPRS	.27	.02	.08	1.22	.60	.30	.24	-.04	.30	1.08
INPLVOL	.41**	.26	.02	.76	1.23	.17	.06	-.10	.54	.86
PROFJOUR	-.39*	-.33*	-.54*	.31	.56	-.25	-.35*	-.68**	.52	1.85
SEMNHOUS	-.18	-.24	-.37	.30	.65	-.03	.01	-.32	.20	.97
SEMBYPRO	-.13	-.02	-.40	.54	.93	-.14	.06	-.23	.98	.29
INTERACT	.15	.15	-.03	.00	.57	.11	-.03	-.01	.69	.38
MANGREXP	.23	.40*	.79***	.91	2.89	.45**	.33	.45	.62	.00
COORGAN	-.12	-.26	-.20	.71	.26	.004	-.03	-.13	.17	.43

Job Completed On or Before Owner's Original Date

The number of full time employees (NUMEMPFL) showed a significant difference (t = 2.64) in its relationship to completing the job on or before the owner's original date (Table 4.10) when the effects of job and planning characteristics were controlled. It had an inverse relationship (-.44). The use of the manager's own experience as a source of CM contract management information (MANGREXP) also showed a significant difference (t = 2.89) when its relationship to completing the job on or before the owner's original date had the effects of job and planning characteristics controlled (.79***).

The percent of preconstruction phase employees who were permanent (.56***) and the use of professional journals (-.39*) had r values which remained relatively constant and significant through both partial correlation procedures (Table 4.10). The first of these had a positive relationship and the second an inverse relationship.

Job Completed On or Before Date Set During Preconstruction Planning

As indicated by Table 4.10, a significant difference (t = 2.37) was shown by the number of CM contracts completed in the last five years (NUMCMCTS). This showed a positive relationship (.72**).

The percent of preconstruction phase employees who were permanent (PRECONEM) had a significant r which remained relatively constant when either job characteristics alone or

both job and planning characteristics were controlled. This was a positive relationship.

Relationship of Planning Characteristics to Meeting Owner Goals

Final Cost Equal To or Less Than Owner's Original Budget

Formal updating of the preconstruction plan (PLNUPDT) had a significant difference in its relationship to final cost equal to or less than owner's original budget when organizational characteristics were controlled (t = 3.29) and when both organizational and job characteristics were controlled (t = 3.84). Both were negative relationships (Table 4.11).

Final Cost Equal To or Less Than Final Pre-Bid Estimate

The use of "risk analysis" (RISKANL) showed a significant difference (t = 3.14) in its relationship to final cost equal to or less than the final pre-bid estimate when organizational and job characteristics were controlled (-.72*).

Jobs Completed On or Before Owner's Original Date

The use of computer estimating techniques during preconstruction planning (CMPEST) showed a significant difference (t = 4.07) in its relationship to jobs completed on or before the owner's original date (.82**) when both organizational and job characteristics had their effects controlled (Table 4.11). The setting of dates for completing the

Table 4.11 Planning Characteristics Related to Measures of Effectiveness: Correlation Coefficients and t-Tests

Planning Characteristic	Measures of Effectiveness: CSTOWNBG SIMPLE[a]	PARTIAL I[b]	PARTIAL II[c]	t I[d]	t II[e]	CSTPREBD SIMPLE	PARTIAL I	PARTIAL II	t I	t II
ONESUPER	.03	.06	.43	.11	1.25	-.004	.01	.02	.05	.07
TMSUPER	.01	.26	.05	.97	.11	.01	.10	.52	.34	1.69
CMPPLN	.22	.23	-.22	.04	1.28	.22	.24	.27	.08	.15
VALENG	.17	.24	.07	.27	.28	.21	.62*[f]	.42	2.00	.65
CMPEST	.17	.35	.42	.72	.78	.14	.27	.54	.51	1.34
PLNVSSIZ	.05	.31	.15	1.02	.29	.02	-.06	.27	.30	.73
SETDTDES	.22	-.37	-.38	2.38[g]	1.83	.25	.02	-.43	.86	2.13
PLNUPDT	.07	-.62**	-.78**	3.29	3.84	.08	-.17	-.30	.95	1.13
RISKANL	.27	.52*	.05	1.10	.62	.05	-.06	-.72*	.41	3.14
DESGNALT	.53***	.34	-.16	.76	1.98	.57***	.51*	.17	.26	1.15
CONSTALT	.41**	.44	.10	.13	.88	.41**	.55*	.49	.63	.26
DECBYOWN	.20	-.21	-.09	1.57	.82	.21	-.05	.54	.97	1.11
DECBYCM	.26	.46*	.74**	.84	2.02	.19	.19	.58*	.00	1.35
DECBYAE	-.13	-.12	-.17	.04	.11	-.10	.07	.03	.64	.37

[a] Simple correlation coefficients

[b] Partial correlation coefficients (controlling for organizational characteristics)

[c] Partial correlation coefficients (controlling for organizational/environmental characteristics)

[d] t-value for Simple and Partial I

[e] t-value for Simple and Partial II

[f] *p.=< .05, **p.=< .01, ***p.=< .001

[g] Underlined t-values are significant at .05 level

Table 4.11 (cont'd)

Planning Characteristic	JOBOMNDT SIMPLE	JOBOMNDT PARTIAL I	JOBOMNDT PARTIAL II	JOBOMNDT t I	JOBOMNDT t II	JOBPREDT SIMPLE	JOBPREDT PARTIAL I	JOBPREDT PARTIAL II	JOBPREDT t I	JOBPREDT t II
	Measures of Effectiveness									
ONESUPER	-.25	-.13	-.05	.45	.57	-.35*	-.25	-.10	.39	.71
TMSUPER	.36*	.35	.66*	.04	1.13	.39	.36	.46	.12	.22
CMPPLN	.06	-.19	-.09	.95	.43	.51**	.68**	.48	.87	.10
VALENG	.06	.03	-.03	.11	.43	.17	.15	-.16	.08	.95
CMPEST	-.003	.16	.82**	.62	4.07	.17	.45*	.53	1.17	1.20
PLNVSSIZ	-.16	-.13	-.11	.11	.14	.24	.42	.40	.74	.49
SETDTDES	.04	-.56*	-.67*	2.71	2.71	.24	-.50*	-.76**	3.20	4.35
PLNUPDT	.16	-.21	-.32	1.42	1.43	.34*	-.18	-.10	2.00	1.25
RISKANL	-.14	-.19	-.45	.19	.98	.12	.29	-.61*	.66	2.61
DESGNALT	.17	-.06	-.34	.86	1.53	.46**	.49*	.21	.13	.72
CONSTALT	.18	-.004	-.01	.69	.54	.34*	.55*	.38	.94	.12
DECBYOWN	.17	.05	.33	.45	.48	.06	-.22	.06	1.07	.00
DECBYCM	.13	-.09	.58*	.83	1.56	.42**	.40	.53	.08	.37
DECBYAE	-.23	-.16	-.37	.27	.43	-.12	.15	-.02	1.02	.28

design phase, during conceptual planning (SETDTDES), had a significant difference in its relationship to jobs completed on or before the owner's original date when organizational characteristics (t = 2.71) and when organizational and job characteristics were controlled (t = 2.71). This was an inverse relationship (Table 4.11).

Jobs Completed On or Before Date Set During Preconstruction Planning

Setting dates for the completion of the design phase, during conceptual planning (SETDTDES), had, as indicated by Table 4.11, a significant difference in its relationship to jobs completed by the date set during preconstruction planning regardless of whether organizational characteristics (t = 3.20) or both organizational and job characteristics (t = 4.35) were controlled. This was an inverse relationship.

The use of "risk analysis" (RISKANL) showed a significant difference in its relationship to this measure of effectiveness (t = 2.61) when the effects of both organizational and job characteristics were controlled. This relationship (-.61*) was an inverse relationship.

Other Organizational and Planning Characteristics Related to Meeting Owner Goals

No other organizational or planning characteristic had a significant difference (t value) in its relationship when other characteristics were controlled (Tables 4.10 and 4.11). Additionally, no other organizational or planning

characteristic had an r value which remained relatively constant, at an acceptable level of confidence, through the partial correlation procedure.

Summary

This chapter has provided a description of the mailing and follow-up procedures utilized for the questionnaire and a discussion of the return rate. The typical company responding to the questionnaire was described in detail.

The significant relationships between organizational characteristics and planning (44 total) and organizational characteristics and job characteristics (20 total) were pointed out. Additionally the significant relationships between job characteristics and planning characteristics (17 total) were noted.

Those significant relationships (7 total) that indicated support for the simple hypotheses were also described. The lack of support for four simple hypotheses was noted.

Described in this chapter, additionally, were those partial correlation coefficients which had a significant difference for organizational characteristics related to measures of effectiveness when the effects of job characteristics were controlled (none significant) and when the effects of both job and planning characteristics were controlled (6 total). Those relationships between planning characteristics and measures of effectiveness which had a significant difference when organizational characteristics were controlled (4 total) and when both organizational and

job characteristics were controlled (7 total) were also noted.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Overview

This chapter discusses those relationships reviewed in Chapter 4 and provides the conclusions reached by the researcher as a result of the analysis performed on the data collected during the research.

Included in this chapter, additionally, are recommendations for further research pertaining to those areas for which the research posed questions but for which the data collected had no satisfactory response.

Limitations

This study had several limitations which may restrict its ability to predict the relative impact which planning, done in the preconstruction phase of a CM contract, has on the CM company meeting an owner's goals. Two of these, even though limitations in one sense, actually increased the confidence with which the statistical analysis could be interpreted.

Sample Size

The first limitation was the size of the sample on which the statistical analysis was performed. Sampling, in

general, is used because it is presumed to be descriptive of a population, a larger collection of entities similar to those found in the sample itself. Sampling helps the researcher cover the greatest possible number of cases within the limit of his or her resources. In return for this gain some degree of certainty must be sacrificed (Ziegenhagen and Bowlby, 1971). A sample size of 32 does, of necessity, lead to a lesser degree of certainty which could be placed in the results, since this small sample may be in some ways dissimilar to CM firms that were not sampled or did not respond. Because the sample size was small, however, the results, especially those concerned with correlation coefficients, are conservative.

Examination of the formula for significance tests given in Chapter 4 will show that level of significance depends on sample size (n) as well as the size of the correlations observed. In a sample size of 32, variables which are found to be significantly related are likely to be of importance in a larger sample or in the population.

Restricted Sample

As was discussed in Chapter 4, in the description of the typical company which answered the survey, the questionnaire was answered by companies which were relatively small. The typical company had less than 50 full time employees, had done less than $30 million in CM contracts over the past five years, and had few, if any, branch offices although they had been in business for between 16-20 years. As a

consequence, the results of the research, and the conclusions drawn from those results, were only applicable to other CM companies in Michigan which fit within those parameters.

Small Standard Deviations

The four measures of the effectiveness with which a CM company meets an owner's goals: CM jobs with a final cost equal to or less than the owner's original budget (CSTOWNBG), CM jobs with a final cost equal to or less than the final pre-bid estimate (CSTPREBD), CM jobs finished by the owner's original date (JOBOWNDT), and CM jobs finished by the date set during preconstruction planning (JOBPREDT), all had fairly small standard deviations. (See Table 5.1.) No matter what shape the distribution of responses, this, the small S.D., meant that a large proportion of these survey responses all had the same answer marked. Other responses on the survey also had small S.D.'s (see Tables 4.1 to 4.3) but these four were especially noteworthy.

Although these small S.D.'s indicated a high level of agreement among the companies surveyed, they also meant that strong correlations are not as likely when other variables were related to these four. That is, because the ranges of the effectiveness variables were small, the greater variance in organizational characteristics, job characteristics, and planning techniques, were less likely to show a linear relationship to effectiveness than if these four measures were spread over a wider range.

Table 5.1. Measures of Effectiveness: Means, Standard Deviations (S.D.), and Ranges

Measure of Effectiveness	Mean[a]	S.D.	Range	
			Low	High
CM Jobs Final Cost ≤ Owner's Original Budget	3.69	.93	None	All
CM Jobs Final Cost ≤ Final Pre-Bid Estimate	3.72	1.14	None	All
CM Jobs Completed By Owner's Original Date	3.45	.92	None	All
CM Jobs Completed By Date Set During Preconstruction	3.72	.68	1-30%	All

[a] The mean given is based on the number (1-5) which corresponds to possible answers on the questionnaire. For an explanation of possible answers, see the questionnaire (Appendix B).

Unuseable Responses

Two sets of questions in the survey instrument had no useable responses marked on the returned questionnaire. These were questions having to do with where the company performed CM work (questions 5-9, Appendix B) and regarding financial ratios (questions 50-52, Appendix).

The series of questions which asked where the company performed CM contracts was designed to indicate if the company was exposed to conditions other than those which exist in Michigan. The lack of this information made the generalization of results to include any companies located outside Michigan unwarranted.

The questions concerning financial ratios were designed to give added validity to the measures of effectiveness. Without these responses it was impossible to draw any conclusions as to the link between effectiveness in meeting an owner's goals and the success of the company as a business enterprise.

Organizational Characteristics Related to Planning Characteristics

Experience

Of the 75 possible correlations between experience related to organizational characteristics and planning characteristics four (5.3%) were found to have a positive relationship while five (6.3%) were found to have an inverse relationship.

Discussion

The longer a company had been in the construction industry, the more decisions affecting planning were made by team members other than the A-E. This seemed to partially support the team concept of decision making, especially for those decisions which affected planning. This supported the work of Adrian (1981) and Foxhall (1972).

The use of "risk analysis" declined the longer a company had been in business. This seemed to support the Business Roundtable (1982) finding that many construction project estimates were prepared without using state-of-the-art techniques for risk analysis.

The longer a company had had an in-house design capability, the more they felt that the owner made a large percentage of the planning decisions while they made less. This length of in-house design experience also was related to the CM company's use of the computer in planning and to having the major role in establishing the communication procedures for the management team.

The more CM contracts they had completed in the last five years, the less likely it was that planning decisions were made by the A-E. This supported Fox's (1976) comment that being structured as a team was not enough. Experience was the key. This indicated that the more experience a construction company had with CM the less likely it was that decisions affecting planning would be left to the A-E.

Conclusions

Based on this sample, and the data collected, it appeared that companies which were older, and more experienced with in-house design capabilities and CM contracts, were more likely to let the owner make decisions affecting planning. They were also more likely to use computers in planning and to take a major role in establishing team communication procedures.

These findings appeared to indicate, at least for the companies surveyed, that the CM firm was concentrating on the planning technology and leaving the major portion of the decision making process to the owner. This contradicts the AGC (1980), ASCE (1976), and Foxhall (1972).

Organizational Size

Organizational size was positively related in 15 out of 75 (20%) possible correlations to planning characteristics. Size was inversely related in only 2 out of 75 (2.6%) correlations possible.

Discussion

Generally, all measures of the physical size of the CM company were positively related to planning characteristics. No significant relationship was detected for any measure of size to the use of one supervisor, planning steps varying with size of the project, the use of risk analysis, or the proposal of design and construction alternatives. The percent of decisions, affecting planning, made by the owner

increased with all measures of size except the number of full time employees. As the number of preconstruction plan employees who were permanent and the volume of CM work possible with their present workforce increased, so did the number of planning characteristic relationships that were significant.

Of particular interest was the finding that the larger the total value of CM contracts completed over the last five years the more the CM company employed "value engineering" and computer estimating techniques. This appeared to support the finding by the Business Roundtable (1982) that the computer estimating hinged on developing a reliable data base which can be achieved through use on multiple projects.

As the total value of the CM contracts completed over the last five years increased, the percent of decisions made by the CM decreased. This supports the previous conclusion that experience was an important factor, for these companies, in the choice to let the owner make decisions affecting planning. As the CM company increased the number of branch offices it had, the A-E made a smaller percent of the decisions affecting planning. This supported fox's (1976) comment mentioned in the preceding section.

Conclusion

The data collected appears to support the writing of Silverman (1976) and Pilcher (1976). This was that the larger and more complex construction projects require a large diversity in skills and techniques, not the least of

which is in the management of the organization. These diverse skills and techniques are more often found in the larger CM firms.

Information

The sources of information to manage CM contracts were found to be positively related in 7 out of 75 (9.3%) possible correlations while they were inversely related in 6 out of 75 (6%) correlations.

Discussion

As the use of in-house seminars, seminars by professionals, and interaction with design firms increased in usefulness as sources of information for managing CM contracts so did the use of a team to supervise the preconstruction planning. As expected, as team use increased the use of one supervisor decreased. This supported the contention by Logcher and Levitt (1976) that the availability of increased information may well exceed the amount a single project manager can process and use. Even though they were writing of MIS generated information the concept appeared to be true here also.

If a company found the use of the manager's experience useful as a source of management information it also decreased the use of computer estimating techniques. The company was also more likely to set dates for completing the design phase and to up-date plans less frequently but to make more of the decisions affecting planning. This was the

only instance where an increase in an organizational characteristic was accompanied by an increase in the percent of the decisions, affecting planning, which were made by the CM. This use of the manager's experience was also related to the company more often proposing design alternatives.

Table 4.1 shows that the manager's experience was the most useful source of information and it showed in the correlation coefficients. This seemed to indicate that the CM companies put an inordinate amount of faith in the correctness of the manager's information concerning planning.

Conclusions

This sample, and the data collected, appeared to indicate that companies which actively seek disparate sources of information used a team approach, more often than not, for planning during the preconstruction phase. It also suggested that the manager's own experience was the factor which decided which of the planning techniques investigated was to be used.

Organizational Form

Discussion

The data collected indicated that companies organized along a line concept were more likely to propose design and construction alternatives and also more likely to make a larger percentage of decisions affecting planning. These findings seemed to support Mintzberg's (1979) concept of the simple structural configuration for the organization. In

this structure direct supervision was the prime coordinating mechanism. The power over all important decisions rested with one individual. The data indicated that that was what happened in the CM company also.

As the organization of the company shifted towards a combination line and staff or staff design, the data indicated that they were more likely to have a major role in establishing team communication procedures but also to update their preconstruction plan less frequently.

Conclusions

The conclusion to be drawn from the analysis of the data was that companies organized along a line form, as opposed to staff, were more likely to propose design and construction alternatives and to make a larger percentage of decisions affecting planning.

General Conclusions: Organizational Characteristics Related to Planning Characteristics

Generally the results supported the findings and beliefs of other researchers and authors. That was that the larger, more experienced companies tended to utilize more of the planning characteristics which were investigated by the study than did smaller, less experienced CM firms.

What was unexpected, and seemingly, contradicts most published concepts of CM was that as the CM company size and experience increased so did the percent of decisions affecting planning made by the owner. This apparent increase in

the decisions made by the owner was related in a positive direction, at a significant level, to more organizational characteristics than any other planning characteristic investigated. A possible explanation of this, and one supported by the data which indicated that a line organization CM company made a larger percent of decisions than did a staff organization, was that the responsibility for decision making became too diffuse in staff organizations.

Organizational Characteristics Related to Environmental Characteristics

Experience

Of the 25 possible correlations between experience related to organizational characteristics and environmental characteristics, three (12%) were found to have a positive relationship while one (4%) was found to have an inverse relationship.

Discussion

As anticipated, the companies which had more experience with CM projects and a larger percentage of their total volume generated by CM contracts also tended to be awarded the larger projects. This suggests popular support for the recommendation by the AGC (1982) and the GSA (1975) that past experience should be a basic consideration when hiring a CM company.

As the years a CM company had had an in-house design capability increased, the value of the smallest project

completed in the last five years decreased. This supported the finding that larger, more experienced CM firms got larger projects. This could be explained by cost effectiveness. It may not be cost effective for a large CM company to split some of its resources among smaller projects, nor for smaller companies to acquire the resources needed for large, complex projects.

Being hired as CM, prior to hiring the A-E, increased as experience with in-house design capability increased. This could indicate that the CM firm was performing the functions of the A-E as well as that of the CM.

Conclusions

As indicated by the data collected, the more experienced CM companies also were awarded the larger jobs.

Organizational Size

Eight of 25 (32%) possible correlations between measures of CM company size and environmental characteristics were found to be positive. Two of 25 (8%) were found to be inversely related.

Discussion

All but one of the measures of size were found to be positively related to the value of the largest CM job completed in the last five years. The one exception was the percentage of preconstruction planning employees who were permanent. These findings supported the conclusion that size, along with experience, appeared to be a major factor

in the award of larger projects. This supported the contention of Diepeveen (1976) and Silverman 91976) that owners did not want the skills gained on a project to be lost at the end of the project. One way of keeping those skills is to have an organization large enough to retain them internally between jobs.

Those CM companies which had a larger total dollar volume of CM contracts (last five years) and were able to do a larger volume of CM work with their present workforce also tended to have owners require a network based scheduling system more often.

CM companies with more branch offices and a larger total value of CM contracts (last five years) appeared to do fewer jobs for private owners. This could indicate that CM jobs done in the public sector were usually larger (dollar value) and that working on those public sector jobs required that branch offices be opened or available.

Conclusions

As found for experience, those companies which were bigger appeared also to be those companies which were awarded the larger CM contracts. Those larger companies also had project owners who required the use of network based scheduling systems. This may be explained by the propensity of the Federal government to require some variation of CPM (GSA, 1975). These larger companies also did fewer private sector contracts than did those that were smaller.

Information

Of the 25 possible correlations between sources of information and environmental characteristics two were found to be positively related (8%) and two were found to be inversely related (8%).

Discussion

The use of the manager's own experience and interaction with design firms as a source of CM contract information increased the more the company performed in the private sector. Additionally, as the value of the largest CM contract completed in the last five years increased, the use of seminars given by professionals and the manager's own experience as a source of management information appeared to decrease.

Conclusions

As indicated by the data collected from this sample, the larger firms appeared to depend less on seminars and the manager's experience than did CM firms which were smaller.

Organizational Form

Staff organizations, as indicated by the data collected, appeared to obtain contracts for larger CM jobs and to do less work in the private sector. This was a further indication that those companies which did the larger CM projects did them in the public sector, as opposed to the private sector, and tended to use staff rather than line organizational designs.

General Conclusions: Organizational Characteristics Related to Environmental Characteristics

In general, as indicated by the data, the larger companies were also the ones which performed on the larger contracts. Also these larger contracts appeared to be in the public rather than the private sector. Additionally, these contracts were indicated as having owners who required a network based scheduling system. A review of Appendix F indicated a strong negative correlation between value of the largest CM project (VALLGRPJ) and percent of CM contracts done for private owners (PVTJOBS) which lent support to this conclusion. The use of network based scheduling systems and private jobs were also correlated in a negative direction.

Environmental Characteristics Related to Planning Characteristics

Value of Smallest Project

Of the 15 possible correlations with planning characteristics, the value of the smallest CM project completed (last five years) was positively related to two (13.3%). It was inversely related to two (13.3%).

Discussion

The use of a team to supervise preconstruction planning increased as the value of the smallest CM project completed increased. As a consequence the use of one supervisor decreased. This appeared to support the conclusion that the larger the project the more likely it was that it was done

by a larger company which used a team concept during preconstruction planning. The use of "value engineering" also increased with the size of the smallest project. This fact, taking into consideration the relationship of "value engineering" to the largest project completed (next section), appeared to support the correlation found between the use of "value engineering" and value of CM contracts, value of largest and smallest project, and being organized along staff lines (Appendix F).

Conclusions

As indicated by the data collected, and supporting previous findings of the study, the larger companies were more likely to use a team approach to planning.

Value of Largest Projects

This was positively related two out of 15 (13.3%) possible correlations and inversely related one out of 15 (6.7%) possible correlations.

Discussion

The value of the largest CM project completed in the last five years had related to its increase the increased use of "value engineering" and the use of computer estimating techniques. These findings added additional depth to the support for these, in some ways, advanced techniques being associated with the larger, more progressive CM companies. The Business Roundtable (1982) felt that the use of computer estimating hinged on developing a reliable data

base. Large companies have better opportunities to develop this needed data base.

As the value of the largest project increased the percent of decisions, affecting planning, made by the CM decreased. This supported previous findings of this study but appeared to contradict the writing of Adrian (1981) and Goldhaber, et al. (1977). The CM is thought to make more of the decisions, not less, on larger projects.

Conclusions

The conclusion to be drawn from this data was, as previously stated, that the larger companies have access to, or at least use more frequently, more complex planning techniques.

Network Based Scheduling Systems Required By Owner

Out of 15 possible correlations to planning techniques the use of a network based scheduling system, as an owner requirement, was positively correlated in four instances (26.7%). It was inversely correlated in four out of 15 instances (26.7%).

Discussion

As the requirement for network based scheduling increased the company was more likely to use one supervisor to supervise preconstruction planning. As previously, the use of a team declined. The use of computer estimating and "risk analysis" increased along with the scheduling system

requirement while proposal of design and construction alternatives decreased. This appeared to indicate that if a network based scheduling system was required that once the schedule was set it was impervious to change. This was also supported by the decline in the percent of decisions made by the CM which affected planning.

Conclusions

The use of a network based scheduling system, as an owner requirement, actually appeared to hinder the proposal of design and construction alternatives. The key here could have been "owner required." It is conceivable that the scheduling systems required by the owner concentrate on carrying out the original design, and leave no time for proposing design alternatives or revisions.

Hiring Sequence

This environmental characteristic was found to be positively related to one planning characteristic (6%).

Discussion

The CM being hired prior to the hiring of the A-E was related, positively, to setting dates for the completion of the design phase during conceptual planning. This characteristic was also related to length of experience with an in-house design capability (Appendix F) and so this relationship may have been another manifestation of the CM firm fulfilling the role of the A-E.

Conclusions

This relationship appeared to support the supposition, indicated by other data collected, that, at least in some cases, it was possible that the CM firm was performing the function of the A-E. This was in addition to their function as CM.

Private Owners

The percent of CM jobs done for private, as opposed to public, owners was positively related to two out of 15 (13.3%) possible planning characteristics. It was inversely related in three out of 15 (20%) possible instances.

Discussion

This environmental characteristic displayed the same behavior, in part, as that discussed for organizational characteristics related to environmental characteristics. That was that the larger contracts, those more likely to require the use of computers and more involved planning, were found doing projects in the public sector. The inverse relationship of the use of computerized estimating techniques and "risk analysis" to the percent of CM jobs done in the private sector appeared to support that finding.

The CM companies sampled also appeared to provide more in the way of design alternatives when they were working on private sector CM contracts. Additionally the percent of decisions, affecting planning, made by the CM increased, at

the expense of decisions made by the A-E, as the CM company did more jobs in the private sector.

Conclusions

The relationship displayed by this environment characteristic related to planning characteristics appeared to support other data collected as to the contention that public sector jobs were larger, more complex, and required more sophisticated planning techniques.

General Conclusions: Environmental Characteristics Related to Planning Characteristics

The relationships in this section seemed to reinforce those found previously that the planning for larger jobs was supervised by a team and that these larger CM jobs were to be found in the public sector. The idea that the more complex the job the more complex the planning required was also supported by this section. This supported Burger and Halpin (1976) in their contention that present day projects were getting larger and more complicated and that this in turn called for an increasingly sophisticated project control.

Measures of Effectiveness (Interrelationships): Discussion

Fifty-eight percent of the variability (see Table 5.2) in completing the project with a final cost equal or less than the owner's original budget (CSTOWNBG) was explained by a final cost equal to or less than the final pre-bid

Table 5.2 Variance (r^2) Explained by Relationship of Dependent Variables

Dependent Variable	CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT
CSTOWNBG	1.00	.58	.19	.32
CSTPREBD	.58	1.00	[a]	.22
JOBOWNDT	.19		1.00	.23
JOBPREDT	.32	.22	.23	1.00

[a]All values not appearing in the body of the table a p. greater than .05.

estimate (CSTPREBD) which also demonstrated the close relationship of those measures of effectiveness linked to dollars. Completing the job on or before the date set during preconstruction planning (JOBPREDT) explained 23% of the variability in meeting the owner's original date (JOBOWNDT). It also partially confirmed the supposition that those measures of effectiveness concerned with dates were linked, at least for the companies surveyed.

Of the variability of completing the project with a final cost equal to or less than the final pre-bid estimates (CSTPREBD), completing the project on or before the date set during preconstruction planning (JOBPREDT) explained 22%. This added additional insight into what had been theorized in Chapter 4. That was that internally set goals were associated, as were goals set more external to the CM company. This latter supposition was supported by the r^2 between jobs completed on or before the owner's original date (JOBOWNDT) and completing the project with a final cost equal or less than the owner's original budget (CSTOWNBG). This r^2 was .22.

The relationship that cut across the boundary of date-cost and internal-external goals was that completing the job on or before the date set during preconstruction planning (JOBPREDT) explained 32% of the variability in final cost equal to or less than the owner's original budget (CSTOWNBG).

Hypotheses

Hypothesis No. 1

Discussion

The hypothesis that the length of time a company had been performing CM contracts had a positive relationship with effectiveness was supported by the relationship of the organizational characteristic, years in CM. This characteristic was positively related in two of four (50%) possible correlations. The percent of CM jobs with a final cost equal to or less than the owner's original budget increased as the years in CM increased. Also increasing along with years in CM was the percent of CM jobs with a final cost equal to or less than the final pre-bid estimate. The data indicated that the years a company had been in the CM field was a factor in meeting those measures of effectiveness most directly linked to dollar value (CSTOWNBG and CSTPREBD) but not those linked most directly with calendar dates (JOBOWNDT and JOBPREBD).

Conclusions

The data collected from this sample indicated that years in the CM field could be used as an indicator of the ability of a CM firm to meet those owner goals related to dollar value but not those related to calendar dates. This, in part, supported the GSA (1975), the AGC (1982), and especially Tatum (1979), in their views that experience in the construction field and the CM field in particular should be used to evaluate a CM firm's potential.

Hypothesis No. 2

Discussion

The hypothesis that the size of a CM company was positively related to effectiveness was supported by the data in six out of 20 (30%) possible correlations. The number of full time employees the CM company had was found, for this sample, to be positively related to the percentage of CM jobs completed by the owner's original date. The percent of preconstruction phase employees who were permanent was found to be the best indicator of effectiveness. It was related, in this sample, to all four of the measures of effectiveness which were surveyed. The percentage of CM jobs completed by the date set during preconstruction planning increased with an increase in the dollar value of CM work which the CM firm could do with its present workforce.

These relationships appeared to support the writings of Fox (1976), Diepeveen (1976), and Silverman (1976) when they argued that the increasingly larger construction projects were making necessary companies which could retain the experience gained from previous projects within the company itself.

Conclusions

Of the five characteristics, pertaining to organizational size, which were investigated, the one which best predicted the ability of a CM company to meet an owner's goals was the percentage of preconstruction phase employees who are permanent employees.

Hypothesis No. 3

Discussion

The hypothesis that exposure of CM managers to sources of information about new management techniques is positively related to effectiveness was not supported by the data gathered as a result of this study. In fact, the use of professional journals as a source of CM contract management information decreased as the percentage of CM jobs finished by the date set during preconstruction planning increased.

Inspection of the means in Table 4.1 will show that, of the five sources of information surveyed, respondents indicated that they found only their own experience useful. The standard deviations for three of these five items was small, indicating a restricted range of responses. Therefore, as previously discussed, significant correlations were not statistically possible.

This lack of usefulness attributed to new information seemed to support the findings by the Business Roundtable (1982) that construction companies were not instituting the modern management systems which were available to other sectors of the business world.

Conclusions

This hypothesis was not supported by the data collected in this study.

Hypothesis No. 4

Discussion/Conclusions

The hypothesis that a network based scheduling system, used during preconstruction planning, had a positive relationship to effectiveness was not supported by the data collected. This lack of significant relationships could have been explained by the way the survey instrument was worded (Question 25, Appendix B). The question asked concerned the proportion of CM jobs where a system was required by the owner, rather than the proportion of jobs on which they were used. To the extent that responding CM firms use such systems when not required by the owner, the data do not provide a valid test of this hypothesis.

Hypothesis No. 5

Discussion

They hypothesis that being hired as a CM prior to the hiring of the A-E was positively related to effectiveness appeared to be supported by the relationship of the environmental characteristic to the two measures of effectiveness related to meeting dates set (JOBOWNDT and JOBPREDT). It was not significantly related to those measures pertaining to dollar values. This appeared to support the concepts of Adrian (1981).

Conclusions

The data collected from this sample appeared to support the hypothesis that being hired as a CM prior to the hiring

of the A-E was related positively to those measures of effectiveness related to meeting dates set.

Hypothesis No. 6

Discussion

The hypothesis that the CM company having the major role in establishing communication procedures for the management team (owner, CM, and A-E) was positively related to effectiveness was supported, for two measures of effectiveness; the percentage of CM jobs with a final cost equal to or less than the final pre-bid estimate, and the percentage of CM jobs completed by the date set during preconstruction planning. Both of these measures of effectiveness were internal to the company itself rather than linked more directly to the owner. This seemed to indicate that establishing team communication procedures was more closely related to meeting internally oriented goals rather than those more externally (to the company) oriented. This appeared to contradict Thompson and McEwen (1958) who stressed the close relationship between goal setting in the organization and effectiveness in the external environment in which the organization operated.

Conclusions

The ability of the CM to establish the team communication procedures was related to the ability of the CM company to meet those internally established measures of

effectiveness, at least in so far as this sample represented the population.

Hypothesis No. 7

Discussion

The hypothesis that project size had no relationship to CM effectiveness appeared to be contradicted by the relationship between the value of the smallest and largest (last five years) CM projects completed and both the final cost equal to or less than the final pre-bid estimate, and the jobs completed on or before the owner's original date. The data indicated that the larger the project the larger percentage of completed CM jobs that met these measures of effectiveness. This contradicted the belief of Linstrom (1982) that CM worked equally well on any size project.

Conclusions

The data collected in this study indicated that the larger a CM project was the larger was the percentage of projects that would be completed with a final cost equal or less than the final pre-bid estimate and on or before the owner's original date.

Hypothesis No. 8 & 9

Discussion/Conclusions

The hypotheses that using computerized estimating techniques and "value engineering" in preconstruction planning had a positive relationship to CM company effectiveness was not verified by the data collected from this sample. No

significant relationship for either characteristic to a measure of effectiveness was evidenced by the findings.

Hypothesis No. 10

Discussion

That using a team to supervise preconstruction planning had a positive relationship to effectiveness was supported by its relationship to the two measures of effectiveness linked most closely to meeting calendar dates. As the use of a team increased so did the percentage of projects completed on or before the owner's original date and on or before the date set during preconstruction planning. This supported the findings by Fox (1976) and Pilcher (1976).

Conclusions

This sample indicated that the use of a team to supervise preconstruction planning was positively related to the CM company's effectiveness in meeting those owner goals linked to calendar dates set.

Hypothesis No. 11

Discussion

The hypothesis that proposal of design and construction alternatives by the CM had a positive relation to effectiveness was the hypothesis for which the simple correlations provided the most support. Proposal of design and construction alternatives was positively related to all measure of effectiveness but percentage of jobs completed on or before the owner's original date. This provided additional support

for the contention of all in the literature, including the AGC (1982), ASCE (1976), and Adrian (1981) that the introduction of construction experience into the design phase by the CM is one of CM's most important aspects.

Conclusions

This data indicated that CM firms which propose design and construction alternatives to the owner are more effective than those which do not.

Hypothesis No. 12

Discussion/Conclusion

The hypothesis that the use of "risk analysis" in preconstruction planning had a positive relationship to effectiveness was not substantiated by the results of this study. No significant relationship was evidenced by the data collected.

Partial Correlation

Organizational Characteristics Related to Meeting Owner Goals

Final Cost Equal To or Less Than Owner's Original Budget (CSTOWNBG)

Discussion

As shown by Table 4.10 the total value of CM contracts completed over the last five years (VALCMCTS) was the only organizational characteristic to show a significant difference (t-value) in its relationship (-.54*) to this measure of effectiveness (CSTOWNBG) when the effects of both

environmental and planning characteristics were controlled. The t-value was not significant when only environmental characteristics were controlled. This meant that, while environmental characteristics were not affecting the relationship, some combination of planning characteristics was.

The relationship was an inverse one. This indicated that as the total value of completed CM contracts became smaller the likelihood of finishing the project with a final cost equal to or less than the owner's original budget increased. This appeared to indicate that smaller, less complex projects were easier to control, and thus more easily met the owner's budget, than were the large complex projects and that planning characteristics played an important role in the ability of the CM company to meet the owner's budget.

The r for company organization (COORGAN) held relatively constant regardless of whether environmental or environmental/planning characteristics were controlled. This inverse relationship indicated that CM companies organized along a line concept, usually a smaller company, were better than staff organizations at keeping a project within budget and that neither the type of job nor the planning done affected this relationship.

The manager's own experience, useful as a source of CM contract management information, (MANGREXP) maintained a significant relationship to meeting the owner's budget irregardless of the control of environmental or environmental/

planning characteristics. This indicated that neither environmental nor planning characteristics affected this relationship and that the use of the manager's experience, a positive relationship, was important, in and of itself, in the capability of a CM company to meet the owner's budget.

The interrelationship between these three company characteristics (VALCMCTS, MANGREXP, and COORGAN) and the ability of the CM company to meet the owner's original budget appeared to support Fox (1976) who said that the builder who executes small units, which are comparatively simple cannot not necessarily conceive, and by implication does not need, of the organization and control mechanisms necessary to manage large projects.

Conclusions

The data collected indicated, by the significant relationships and significant t-values, that smaller, line organization CM companies, who rely on the manager's experience for management information, appeared better able to meet the owner's budget than did larger companies. This was indicated as applying to smaller CM projects. A possible explanation may have been that small projects, done by large CM companies, tended to fragment the resources available to large companies and that management had a harder job tracking actual cost as related to the budget.

Final Cost Equal To or Less Than Final Pre-Bid Estimate (CSTPREBD)

Discussion

When the effects of both environmental and planning characteristics were controlled the number of years that a company had been in the construction business (YRSNBUS) was found to have a significant t-value for its relationship to final cost of a project equal to or less than the final pre-bid estimate (CSTPREBD). This indicated that younger, and thus usually smaller, companies were more likely to complete a project at, or under, the cost given in the final pre-bid estimate than were older companies. This finding was not supported by available literature and seemed to contradict the AGC (1982), the GSA (1975), and Tatum (1979) who felt that past experience was a good indication of potential.

This relationship was not evident when only the effects of environmental characteristics were controlled but appeared when the effects of environmental and planning characteristics were controlled simultaneously. This indicated that, at least for young companies, planning characteristics, and not environmental characteristics, were important factors in their ability to meet the final pre-bid estimate.

Conclusion

The data collected indicated that younger, less experienced CM companies completed a larger percentage of CM projects with a final cost equal to or less than the final pre-bid estimate than did older, more experienced companies.

It also indicated that some combination of planning characteristics had a more important affect on this relationship than did environmental characteristics. A possible reason for this may have been that younger companies approach the CM process in a more innovative manner. Although this was not generally supported by this study one possible indication is the relationship (Appendix F) of years in business (YRSNBUS) to the use of "risk analysis" (-.30*). This was that younger companies appear to use "risk analysis" on more projects than did older companies.

Job Completed On or Before Owners Original Date

Discussion

As shown by Table 4.10 the relationship of the number of full time employees (NUMEMPFL) to completing the job on or before the owner's original date was not a significant relationship when either environmental or environmental/ planning characteristics were controlled. What was indicated as being significant was the change in t-values when both environmental and planning characteristics were controlled. Additionally this appeared to suggest that what had made this a significant relationship was the effect which planning had on the relationship.

The use of the manager's experience as a source of CM contract information (MANGREXP) showed a significant t-value when its relationship to completing the job by the owner's original date had the effects of both environmental and

planning characteristics controlled. The t-value was not significant when only environmental characteristics were controlled. This appeared to indicate that not only was the manager's experience important, in a positive manner, but the effect of the planning characteristics was important also. This supported the findings of the ASCE (1975).

Both the percentage of preconstruction phase employees who are permanent (PRECONEM) and the use of professional journals as a source of CM contract management information (PROFJOUR) maintained relatively constant r values regardless of which other characteristics was controlled. The first was a positive relationship while the second was inverse. This meant that for these two company characteristics the effect of environment and planning were negligible.

The higher the percentage of preconstruction phase employees who were permanent employees the better the CM companies surveyed appeared to do in completing the job on or before the owner's original date. This finding support the argument of Fox (1976), among others, that being structured as a team was not enough. They (the team) needed to be able to work as a team and could only come from having worked as a team previously.

The use of professional journals as a source of CM contrast information maintained a relatively constant negative r during both partial correlation procedures. This appeared to indicate that, although unaffected by environmental or planning characteristics, the companies in the

survey got their CM contract management information from other sources.

Conclusions

Planning characteristics had an important impact on the relationships of both tne number of full time employees and the use of a manager's experience as an information source to completing the job on or before the owner's original date.

This data also appeared to support the argument of Fox (1976) mentioned previously.

Jobs Completed On or Before Date Set During Preconstruction Planning

Discussion

The effects of planning characteristics were important to the relationship of the total number of CM contracts completed in the last five years (NUMCMCTS) to completing the job on or before the date set during preconstruction planning (JOBPREDT). When environmental characteristics were controlled alone the t-value was not significant. When both environmental and planning characteristics were controlled the t-value was significant and this indicated that some interaction of planning characteristics had an important effect.

This finding indicated that the more CM contracts a company had completed in the last five years the larger percentage of projects they completed on or before the date set during preconstruction planning. Also suggested was

that the use of some combination of the planning characteristics investigated was important to the ability of the CM company to meet that date. This supported the majority of the literature reviewed (Goldhaber, et al., 1977; GSA, 1975; AGC, 1982; Tatum, 1979; Clough and Sears, 1979) in that the experience gained in planning a larger number of projects appeared to be a major factor in completing the project on or before the date set during preconstruction planning.

As was found for completing the job on or before the owner's original date (JOBOWNDT) the relationship of the percentage of preconstruction planning employees who were permanent employees (PRECONEM) to completing the job on or before the date set during preconstruction planning was unaffected by either environmental or planning characteristics. This provided additional support for the views of Fox (1976).

Conclusion

For the data collected planning had a positive impact on the relationship between the number of CM contracts completed in the last five years (NUMCMCTS) and the percentage of jobs completed on or before the date set during preconstruction planning. Additionally, neither environmental nor planning characteristics had an observable effect on the relationship of percentage of preconstruction planning employees who were permanent employees to competing the job on or before the date set during preconstruction planning.

Planning Characteristics Related to Meeting Owner Goals

Final Cost Equal To or Less Than Owner's Original Budget

Discussion

The formal updating of the dates set in the company's plan for the preconstruction phase (PLNUPDT), in its relationship to projects with a final cost equal to or less than the owner's original budget (CSTOWNBG), showed a significant difference in the value of its r when organizational characteristics were controlled and when organizational and environmental characteristics were both controlled. Both of these were inverse relationships which meant that those companies who updated their planned dates more frequently appeared to meet the owner's original budget more often than those companies who were less frequent in their updates. The fact that this relationship changed from not being significant, to being significant in both cases, indicated that, when the effects of either organizational characteristics alone or company and environmental characteristics together were controlled, frequent updating of planned dates had an important positive impact on the ability of a CM company to complete a project with a final cost equal to or less than the owner's original budget.

This finding supported Densmore and Burgoine (1981) in their contention that if proper planning were achieved the project would be completed with the best use of available resources and would be successful. Additionally, this

supported the Business Roundtable (1983) in their finding that, through better planning, construction time on most projects could be reduced by 10% and consequently reduce the costs.

After the removal of the effects of organizational characteristics the r value of decisions affecting planning, made by the CM (DECBYCM), stayed relatively constant when the effects of organizational and environmental characteristics were also controlled. This appeared to indicate that the interaction of organizational and environmental characteristics were having a masking effect on the importance of the CM making planning decisions and its relationship to the ability of a CM firm to meet the owner's original budget.

Adrian (1981) stated that being involved with a project throughout design, construction and implementation placed the CM in a position to minimize the project's time and cost. This finding of increased decisions by the CM appeared to support that argument.

Conclusions

The analysis of the data collected indicated that frequent updating planned dates enabled a CM company to more often complete a project at or under the owner's original budget. In addition, it appeared that increasing the decisions made by the CM, which affected planning, also increased the ability of the CM company to meet the owner's original budget.

Final Cost Equal To or Less Than Final Pre-Bid Estimate

Discussion

The use of "risk analysis" in preconstruction planning (RISKANL) showed a significant difference in its relationship to final cost equal to or less than the final pre-bid estimate (CSTPREBD) when the effects of organizational and environmental characteristics were controlled. Its inverse relationship indicated that the less those companies surveyed used it the more likely they were to complete the project with a final cost equal to or less than the final pre-bid estimate. The fact that this planning characteristic became significant only after both organizational and environmental characteristics were controlled indicated that it was the environmental or job characteristics that had the major effect. Although one of the stated services which a CM firm should offer (Adrian, 1981; AGC, 1982; ASCE, 1976) for these companies it appeared that the majority of the jobs (owners) did not require it. For this study a factor may have been that the companies surveyed were all relatively small (Appendix E) and that "risk analysis" appeared to be associated with jobs done in the public sector, which in this study, were done by large companies with the presumably large resources needed to perform "risk analysis."

Conclusions

The use of "risk analysis," for the companies surveyed, appeared to decrease with the increased ability of a CM

company to complete a project with a final cost equal to or less than the final pre-bid estimate.

Jobs Completed On or Before Owner's Original Date

Discussion

The use of computerized estimating techniques in pre-construction planning (CMPEST) displayed a significant change in its relationship to jobs completed on or before the owner's original date (JOBOWNDT) when both organizational and environmental characteristics were controlled but not when organizational characteristics were controlled alone. This indicated, for these companies, that the job required the use of computerized estimating techniques rather than any internal company requirement. The positive relationship indicated that jobs on which computerized estimating was used more often met owner's original completion date than those on which it was not.

Although these findings supported Adrian (1981) and Clough and Sears (1979), they more fully supported the Business Roundtable (1982) finding that computer estimating systems were not fully utilized by the construction industry. The data in the present study appeared to indicate that the use of computerized estimating was more a function of the job than of any policy within the CM company itself. Logic would seem to indicate that if a CM company had the system available it would be used for all jobs, regardless of any special characteristics of the individual job.

Setting dates, during conceptual planning, for completing the design phase (SETDTDES) showed a significant change in r values when either organizational or organizational and environmental characteristics were controlled. This relatively constant negative relationship appeared to be affected by some combination of organizational characteristics and not by environmental characteristics. The data indicated that these companies were better off not to set dates for completing the design phase. Setting them led to not completing the job by the owner's original date. This same relationship was found to be true for completing the job by the date set in preconstruction planning also. (See next section.)

Conclusions

The conclusion supported by this data was that using computerized estimating was a function of environmental (job) requirement rather than internal CM company policy and that on jobs where it was used it had a positive impact on completing the job on or before the owner's original date. Additionally, setting dates, during conceptual planning, for completing the design phase had a negative influence on meeting the owner's original completion date.

Jobs Completed On or Before Date Set During Preconstruction Planning

Discussion

The use of "risk analysis" during preconstruction planning (RISKANL) showed a significant difference in its

relationship to jobs completed on or before the date set during preconstruction planning (JOBPREDT) when both organizational and environmental characteristics were controlled. This significant t-value was not evidenced when only organizational characteristics were controlled. This indicated, as for its relationship to meeting the final pre-bid estimate, that this planning characteristic was affected most by environmental or job characteristics and not any internal company characteristic. It also showed the same inverse relationship. For a full discussion of the possible explanation for this, see the section of this study entitled "Planning Characteristics Related to Meeting Owner Goals: Jobs Completed On or Before Date Set During Preconstruction Planning."

The data collected also indicated that the negative aspect of using "risk analysis" was in some way a function of goals set within the CM company. It had a significant negative relationship with the two measures of effectiveness linked most directly with the CM company (CSTPREBD and JOBPREDT) but had no significant relationship with those linked most directly to the owner (CSTOWNBG and JOBOWNDT) when both organizational and environmental characteristics were controlled. This seemingly contradicted Adrian (1981) who argued that this procedure was of benefit to the owner rather than the CM company.

As was indicated by the data for meeting the owner's original date, the setting of dates, during the conceptual

planning, for completing the design phase (SETDTDES) had a significant t-value in its relationship to completing the job on or before the date set during preconstruction planning when either organizational characteristics alone or when both organizational and environmental characteristics were controlled. The data indicated that this planning characteristic's negative relationship was affected by some combination of organizational characteristics and not by environmental characteristics.

Conclusions

The data collected and analyzed in this study indicated that those companies surveyed did not use "risk analysis" to any extent and that by not using it they were better able to meet the completion date set during preconstruction planning. Additionally, the use of this planning characteristic was a function of some interaction of organizational characteristics as opposed to environmental characteristics. The setting of dates for completing the design phase, during conceptual planning, was indicated by the data collected by this study to impede the ability of the CM company to complete the project on or before the date set during preconstruction planning.

Discussion Summary

Simple Correlations

As indicated by Tables 4.5, 5.3, and in the discussion of the results, the larger, more experienced companies

Table 5.3 Summary of Organizational Characteristics Related to Planning Characteristics

Organizational Characteristic[a]	Total Planning Characteristics Related	
	Positive Relation	Inverse Relation
- Experience		
YRSNBUS	ø	2
YRSNHSE	3	1
NUMCMCTS	ø	1
- Size		
NUMBRNCH	2	1
NUMEMPFL	3	1
VALCMCTS	3	1
PRECONEM	4	ø
VOLWKPRS	4	ø
- Information		
PROFJOUR	1	ø
SEMNHOUS	ø	1
SEMBYPRO	1	2
INTERACT	1	2
MANGREXP	5	1
- Organization		
COORGAN	2	3

[a]These organizational characteristics are not rank-ordered. The data collected did not support that type of conclusion.

tended to utilize more of the planning characteristics which this study investigated than did the smaller, less experienced CM firms. This study also found that the use of outside sources of CM contract information was inversely related to the majority of the planning characteristics investigated. Those companies surveyed relied most heavily on the manager's own experience.

Tables 4.6 and 5.4 indicate that the larger CM contracts, at least for the surveyed companies, appeared to be in the public and not the private sector. Additionally most of the owners for these larger contracts required the use of a network based scheduling system. These scheduling systems did not appear to be generally required by the private sector owners.

The larger jobs were also found to be those which, for the companies surveyed, required the use of more sophisticated project controls and the use of more varied planning (Tables 4.7 and 5.5).

Simple Hypotheses

Of the simple hypotheses which this study investigated, seven (58%) were supported by the data while five (42%) were not supported by the data. The majority of those found to be supported by the research were those that related, in some form, the size of the CM company to increased effectiveness, rather than the use of some planning characteristic. The major exception to this was the proposal of design and construction alternatives by the CM. This was related

Table 5.4 Summary of Organizational Characteristics Related to Environmental Characteristics

Organizational Characteristic[a]	Total Environmental Characteristics Related	
	Positive Relation	Inverse Relation
- Experience		
YRSNHSE	1	1
NUMCMCTS	1	ø
- Size		
NUMBRNCH	1	1
NUMEMPFL	2	ø
VALCMCTS	2	1
PRECONEM	1	ø
VOLWKPRS	2	ø
- Information		
SEMBYPRO	ø	1
INTERACT	1	ø
MANGREXP	1	1
- Organization		
COORGAN	1	1

[a]These organizational characteristics are not rank-ordered. The data collected did not support that type of conclusion.

Table 5.5 Summary of Environmental Characteristics Related to Planning Characteristics

Environmental Characteristics[a]	Total Planning Characteristics Related	
	Positive Relation	Inverse Relation
Value of smallest project completed in last five years	1	2
Value of largest project completed in last five years	2	1
Network based scheduling system required by owner	2	4
CM hired prior to hiring of A-E	1	ø
Percentage of private jobs, as opposed to public jobs	2	3

[a]These environmental characteristics are not rank-ordered. The data collected did not support that type of conclusion.

positively to all measures of effectiveness except completing the job by the owner's original date (See Table 4.9).

Partial Correlations

Organizational Characteristics Related to Meeting Owner Goals

As indicated by Figure 5.1, when both environmental and planning characteristics were controlled the data indicated that planning was affecting the relationship of the value of CM contracts completed (last five years) (VALCMCTS) to final cost equal to or less than the owner's original budget (CSTOWNBG). Planning also had an impact on the relationship of years in the construction industry (YRSNBUS) to final cost equal to or less than the final pre-bid estimate (CSTPREBD). This impact of planning was also seen in the relationship of number of full time employees (NUMEMPFL) and the use of manager's own experience (MANGREXP) to completing the job by the owner's original date (JOBOWNDT). Planning, as indicated by the data, has an effect on the relationship of the number of CM contracts completed in the last five years to completing the job on or before the date set in preconstruction planning.

All of these effects were seen only after controlling for the environmental and planning characteristics and not when controlling for only environmental characteristics. This indicated that planning, and not environmental, characteristics were affecting these relationships.

Organizational Characteristic	Measure of Effectiveness Effected	Relationship
Value of total CM contracts completed in last five years	Final cost =< owner's original budget	Inverse
Years in the construction industry	Final cost =< final pre-bid estimate	Inverse
Use of manager's own experience as a source of CM contract management information	Job completed on or before owner's original date	Positive
Total number of CM contracts completed in last five years	Job completed on or before date set during precon-struction planning	Positive

Figure 5.1 Organizational Characteristics Whose Relationship to Meeting Owner's Goals Was Affected by Planning

Planning Characteristics Related to Meeting Owner Goals

As indicated by Table 5.6 environmental (job) characteristics were found to be the important factors influencing the use of "risk analysis" (RISKANL) and computerized estimating techniques (CMPEST) in their relationships to the measures of effectiveness. This was shown by the action of the t-values when, in addition to controlling organizational characteristics, environmental characteristics were controlled also.

Updating the dates set during preconstruction planning (PLNUPDT) and setting dates for the completion of the design phase during conceptual planning (SETDTDES) were affected by both organizational and environmental characteristics.

Study Synopsis

This study was designed to investigate the effects of planning, during the preconstruction phase of a CM job, on the effectiveness of the CM company in meeting owner goals. More specifically, it was an attempt to determine the relative impact of planning, on CM company effectiveness, when compared to the impact of the CM company's organizational characteristics and the job environment in which the company worked.

Although some aspects of planning, in general, were indicated as affecting the ability of the CM company to meet the goals of the owner the results of the study appeared to follow no clear pattern. The factor that did stand out in a

Table 5.6 Planning Characteristics Whose Relationship to Meeting Owner's Goals Was Affected by Organizational and/or Environmental Characteristics

Planning Characteristic	Related To	Effected by		Relationship	
		Organizational Characteristics	Environmental Characteristics	Organizational Characteristics	Environmental Characteristics
Updating those dates set during preconstruction planning	Final cost =< owner's original budget	XXX	XXX	Negative	Negative
The use of "risk analysis"	Final cost =< final pre-bid est.		XXX	N/A	Negative
The use of computerized estimating techniques	Job completed on or before owner's original date		XXX	N/A	Positive
Setting dates for the completion of the design phase during conceptual planning	Job completed on or before owner's original date	XXX	XXX	Negative	Negative
Setting dates for the completion of the design phase during conceptual planning	Job completed on or before the date set during preconstruction planning	XXX	XXX	Negative	Negative
The use of "risk analysis"	Job completed on or before the date set during preconstruction planning		XXX	N/A	Negative

discernible manner was that the success of a company in meeting an owner's goals, as measured by this study, was more the result of an interaction of organizational and environmental characteristics than the clear cut action of the planning characteristics investigated. That is not to say that planning does not have a beneficial impact, logic says that it does, but that the relationship which specific planning characteristics have with success in meeting an owner's goals was unable to be delineated by this research.

Recommendations for Future Research

Some questions which arose during the course of this study were unable to be answered either through the data collected in the study or through the available literature. The areas to which these unanswered questions pertain need to be investigated further in order that the underlying relationships may be better understood.

The areas suggested for further study, in no particular order of importance, are:

- The interaction of the decision making process between the owner, CM, and A-E under CM contracts.
- Sources of CM contract management information, other than managers' experience.
- The use of goal setting in CM companies.
- Is the effective use of CM limited to any certain range of project sizes/values?
- Why do younger CM companies appear to meet final pre-bid estimates better than more established ones?

- How wide spread is the use of computerized estimating in the CM field?
- Why did the use of "risk analysis" appear to be negatively related to goals set internal to the CM company and positively related to externally linked goals?

Finally, the pattern of correlations among the effectiveness measures and the other results suggests that effectiveness in CM companies is multidimensional, and involves both internal-external and date-cost dimensions. These study results lend credence to the writings of Mintzberg (1979), Miles (1980), and Jurkovich (1974) reviewed in Chapter 2. The organizational, environmental, and planning characteristics that are related to one aspect of effectiveness are not usually associated with the other aspects. This suggests that future research is needed to investigate (1) the relationships, including potential conflicts, among dimensions of effectiveness in CM firms, (2) other dimensions of effectiveness, including profitability and growth, and (3) the specific types of organizational, environmental, and planning characteristics associated with each aspect of effectiveness. Meanwhile, these results suggest that caution may be needed on the part of writers--and readers--of literature who assume effectiveness to be unidimensional, and who make blanket statements about the need for, and positive effects of, aspects of the management of CM projects and firms.

Summary

This chapter discussed the significant results of the research, as indicated in Chapter 4. Also noted were the conclusions drawn by the researcher as the consequence of those results.

Remarked on in the discussions presented in this chapter was whether or not the results of this research supported or contradicted past research or information presented by CM literature.

Finally, this chapter recommended areas for future research and a warning of the dangers of drawing unwarranted conclusions from either this study or the writings of others pertaining to CM.

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APPENDICES

APPENDIX A

List of Construction Management Contractors

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List of Construction Management Contractors

The A. M. E. Group, Inc.
1825 Brinston Ave.
Troy, MI 48084

ASR Multi Construction, Inc.
5600 Crooks Rd., Suite 200
P.O. Box 10
Troy, MI 48099

Adair-Chaldecott Construction Co., Inc.
4027 E. Nine Mile Rd.
Warren, MI 48091

Amurcon Corp.
26555 Evergreen, Suite 1717
Southfield, MI 48076

A. J. Anderson Construction Co.
21044 Kelly Rd.
East Detroit, MI 48021

Atomic Construction, Inc.
20043 W. Ballantyne Ct.
Grosse Pte. Woods, MI 48236

Geo. W. Auch Co.
3646 Mt. Elliott Ave.
Detroit, MI 48207

Barton-Malow Co.
13155 Cloverdale
Oak Park, MI 48237

Brown-Schroeder & Co.
Box 27
Richmond, MI 48062

Webster Buell
27630 Southfield Rd.
Lathrup Village, MI 48076

H. F. Campbell Co.
9301 Michigan Ave.
Detroit, MI 48210

Oscar J. Chapaton
39288 Dodge Pk. Rd.
Sterling Hts., MI 48078

Chapoton General Contracting Co., Inc.
32625 W. Seven Mile Rd.
Livonia, MI 48152

The Christman Co.
408 Kalamazoo Plaza
Box 14120
Lansing, MI 48901

The Christman Co.
G-3512 W. Bristol Rd.
Box 248
Flint, MI 48501

Christopher Construction Co.
8345 Lynch Rd.
Detroit, MI 48234

Clark Construction Co.
P.O. Box 40087
Lansing, MI 48901

Edward Colbert/Systems
237 N. Woodward
Birmingham, MI 48011

Collins & Catlin, Inc.
P.O. Box 529
Port Huron, MI 48060

Comprehensive Management Services, Inc. (CMSI)
220 W. Congress
Detroit, MI 48226

Construction Management, Inc.
21800 W. Ten Mile Rd.
Southfield, MI 48075

Walter L. Couse & Co.
12740 Lyndon Ave.
Detroit, MI 48227

Cunningham-Limp Co.
1400 N. Woodward
Birmingham, MI 48011

D. J. R., Inc.
227 Iron
Detroit, MI 48207

R. E. Dailey & Co.
19200 W. Eight Mile Rd.
Southfield, MI 48075

Ken Daly General Contractor, Inc.
1520 N. Woodward, Suite 107
Bloomfield Hills, MI 48013

Danic Co.
16338 Andover Dr.
Fraser, MI 48026

Darin & Armstrong, Inc.
23999 Northwestern Hwy.
Southfield, MI 48075

Henry de Koning Construction Co.
2459 S. Industrial Hwy.
Ann Arbor, MI 48104

Dumas Concepts in Building, Inc.
9215 Michigan Ave.
Detroit, MI 48210

J. L. Dumas & Co.
1000 Long Blvd., Suite 8
Lansing, MI 48910

R. W. Edgar & Co.
2852 Benson
Detroit, MI 48207

Elgin Builders, Inc.
21415 Civic Center Dr.
Suite 211
Southfield, MI 48076

Elzinga & Volkers, Inc.
86 E. 6th
Holland, MI 49423

The Emanuel Co.
14385 Wyoming Ave.
Detroit, MI 48238

Etkin, Johnson & Korb, Inc.
10111 Capital Ave.
Oak Park, MI 48237

Felker Construction Co.
8226 Michigan Ave.
Detroit, MI 48210

Ferguson, Hogle, Brassell Constr. Co.
(J. A. Ferguson Constr. Co.)
32715 Folsom Rd.
Farmington, MI 48024

Fordon Construction Co.
28000 Middlebelt Rd.
Farmington, MI 48018

J. A. Fredman, Inc.
735 S. Paddock St.
Pontiac, MI 48053

Freeman-Darling, Inc.
20337 Middlebelt Rd.
P.O. Box 66
Livonia, MI 48152

The Garrison Co.
24400 Indoplex Circle
Farmington Hills, MI 48018

E. Gilbert & Sons, Inc.
45887 Mound
Utica, MI 48087

Granger Construction Co.
6267 Aurelius Rd.
P.O. Box 22187
Lansing, MI 48909

R. C. Hendrick & Son, Inc.
P.O. Box 1886
427 Atwater St.
Saginaw, MI 48605

Elise Hosten-McGough & Associates
2809 Saddlewood Rd.
Orchard Lake, MI 48033

Irving-James Corp.
26561 W. Twelve Mile Rd.
Suite 207
Southfield, MI 48034

Paul H. Johnson, Inc.
225 Merrill
Birmingham, MI 48011

F. J. Jones & Co.
24333 Southfield Rd.
Suite 104
Southfield, MI 48075

Kapila Contracting Co., Inc.
7439 Middlebelt Rd.
Suite 2
West Bloomfield, MI 48033

Kingston Contractors, Inc.
19675 W. Ten Mile Rd.
Southfield, MI 48075

D. M. Kitchen Building Co.
1925 Heide St.
Troy, MI 48084

Robert J. Koepsell Building Co.
23780 Mack Ave.
St. Clair Shores, MI 48080

Matthew Lalewicz, Inc.
P.O. Box 847
Bloomfield Hills, MI 48013

D. W. Lewis & Co.
24655 Southfield Rd.
Suite 100
Southfield, MI 48075

MSI Construction Managers
23309 Plymouth Rd.
Detroit, MI 48239

K. H. Mahnick & Associates, Inc.
5700 Orion Rd.
Rochester, MI 48064

Manix Inc.
6785 Telegraph Rd.
Glover Bldg., Suite 101
Birmingham, MI 48010

F. H. Martin Construction Co.
22700 Wood St.
St. Clair Shores, MI 48080

Master Plan Construction
Div. of Leo's Corp.
555 Oliver St.
Troy, MI 48084

Miller-Davis Co.
P.O. Box 2367
1029 Portage St.
Kalamazoo, MI 49003

Edward V. Monahan, Inc.
21321 Kelly Rd.
East Detroit, MI 48021

J. G. Morris Co.
8600 Church Rd.
Grosse Ile, MI 48138

Newmyer Contracting, Inc.
1700 N. Opdyke Rd.
Pontiac, MI 48057

North Construction Co.
401 N. Jackson
P.O. Box 116
Jackson, MI 49204

R. L. Owen Co.
7771 Auburn Rd.
Utica, MI 48087

Palmer-Smith Co.
20840 Southfield Rd.
Suite 200
Southfield, MI 48075

Paragon Construction Corp.
12433 E. Eight Mile Rd.
Warren, MI 48089

Parliament Construction Co.
30200 Telegraph
Suite 251
Birmingham, MI 48010

K. Pemberton Construction Co., Inc.
12641 Stark Rd.
Livonia, MI 48150

Joseph Pope Construction Co.
477 N. Dixie Hwy
P.O. Box 983
Monroe, MI 48161

Prater, Wells & Associates Ltd.
19847 James Couzens Hwy
Detroit, MI 48235

Pyramid Construction Co., Inc.
31471 Northwestern Hwy.
Farmington Hills, MI 48018

Remer + Webber Construction Programmers
3260 Coolidge Hwy.
Berkley, MI 48072

Roberts & Dudlar, Inc.
20525 Freemont
Livonia, MI 48152

A. Z. Shmina & Sons Co.
13000 Newburgh Rd.
P.O. Box 2129
Livonia, MI 48151

Smith & Andrews Construction Co.
13100 Northend
P.O. Box 3845
Oak Park, MI 48237

Spence Brothers
417 Mc Coskry St.
P.O. Box 1568
Saginaw, MI 48605

Strobl Construction Co.
5612 E. Davison Ave.
Detroit, MI 48212

Talbot & Meier Inc.
1000 Larchwood
Detroit, MI 48203

Taubman Construction, Inc.
3270 W. Big Beaver Rd., Suite 300
P.O. Box 3270
Troy, MI 48099

Time Construction Co., Inc.
2526 Bretby
Troy, MI 48098

True Management, Inc.
8344 Hall Rd.
Utica, MI 48087

Turner Construction Co.
932 Fisher Bldg.
Detroit, MI 48202

Utley-James, Inc.
1100 Opdyke Rd.
P.O. Box 1100
Pontiac, MI 48056

Robert Van Kampen Co.
12836 Fenkell
Detroit, MI 48227

Aldinger Walbridge Co.
38099 Schoolcraft
Livonia, MI 48150

Glenn E. Wash & Associates, Inc.
14541 Schaefer
Detroit, MI 48227

Waterford Construction Co.
4511 Highland Rd.
Pontiac, MI 48054

K. H. Wehner (P.E.) Engineering & Construction Consultants
6265 Tripp Rd.
Holly, MI 48442

M. Weingarden Associates, Inc.
20900 Hubbell
Oak Park, MI 48237

P. H. Williams & Son, Inc.
20070 Coryell
Birmingham, MI 48010

Williams & Richardson Co., Inc.
10611 W. McNichols Rd.
Detroit, MI 48221

Woodland Construction, Inc.
30850 Groesbeck
Roseville, MI 48066

APPENDIX B

SURVEY INSTRUMENT

MICHIGAN STATE UNIVERSITY

BUILDING CONSTRUCTION PROGRAM
AGRICULTURAL ENGINEERING BUILDING
(517) 355-4720

EAST LANSING · MICHIGAN · 48824

March 1984

Dear Construction Executive,

I am doing Master's thesis research in the Building Construction Program of the Agriculture Engineering Department, Michigan State University. I would like to be able to identify those aspects of a company's pre-construction planning which contribute to organizational success in the field of CONSTRUCTION MANAGEMENT.

The voluntary participation of your company in the study is important. A high rate of return in the survey will enable me to better define those aspects of planning which are important to companies in the field of CONSTRUCTION MANAGEMENT in Michigan. In return, on request, I will provide feedback to your company regarding results.

The absolute anonymity and confidentiality of your response is guaranteed. Please do not put your name or identify your firm on the questionnaire. Upon receiving your completed questionnaire I will load your response into the computer, and then destroy your questionnaire. Data will be aggregated across the entire sample only by such classifications as company size, etc. No individual company data will be used or made public.

Even though your company may have other types of construction operations, this survey is targeted only to those projects which your company undertakes under a CONSTRUCTION MANAGEMENT form of contract. The term 'CONSTRUCTION MANAGEMENT' is used here as defined by either The American Society of Civil Engineers or the Associated General Contractors of America. Questions are asked about the characteristics of your company and the type of CONSTRUCTION MANAGEMENT projects it undertakes, planning conducted during the pre-construction phase, and how your company measures its performance.

I am hoping to have your completed questionnaire within two weeks. Should you have difficulty with this request or regarding the questionnaire, please do not hesitate to contact me. This research is totally supported by my own funds and not affiliated with a consulting firm or national organization.

Sincerely,

David A. Boothe

David A. Boothe
(517) 351-5571

Would you like a copy of the feedback report? Please telephone me at 353-0781 or write. To ensure your anonymity, please do not include a written request on the questionnaire you return.

This section of the questionnaire asks questions about the characteristics of your company. Please circle the answer for each question which best describes how you see your company in relationship to the question.

1. How many years has your company been offering its services, in some form, to the construction industry?

   (1) 1-5 yrs (2) 6-10 yrs (3) 11-15 yrs (4) 16-20 yrs (5) over 20 yrs

2. How many years has your company been offering CONSTRUCTION MANAGEMENT services as defined by the A.S.C.E. or the A.G.C.?

   (1) 1-3 yrs (2) 4-6 yrs (3) 7-9 yrs (4) 10-12 yrs (5) over 12 yrs

3. How many years has your company had an in-house design capability?

   (1) None (2) 1-5 yrs (3) 6-10 yrs (4) 11-15 yrs (5) over 15 yrs

4. How many branch offices, not including field offices, does your company have?

   (1) None (2) 1-5 (3) 6-7 (4) 11-15 (5) over 15

What percent of your company's CONSTRUCTION MANAGEMENT projects are done:

5. in Michigan?
   (1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

6. in mid-western states?
   (1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

7. in the continental United States?
   (1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

8. in the USA, Canada, and Mexico?
   (1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

9. world wide?
   (1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

10. How many full time employees, excluding trades (carpenters, electricians, etc.), does your company have?

    (1) fewer than 50
    (2) 51 to 150
    (3) 151 to 250
    (4) 251 to 350
    (5) over 350

11. How many CONSTRUCTION MANAGEMENT contracts has your company completed in the last five years?

(1) 1-10 (2) 11-20 (3) 21-30 (4) 31-40 (5) over 40

12. What is the approximate total value, excluding real estate cost, of the new construction which your company has put-in-place under CONSTRUCTION MANAGEMENT contracts in the last five years?

(1) Less than $2.5 mill (2) $2.5-30 mill (3) $30-60 mill (4) $60-90 mill (5) over $90 mill

13. What percent of those individuals whom your company usually employs, during the pre-construction phase of a CONSTRUCTION MANAGEMENT project are <u>permanent</u> employees?

(1) less than 20% (2) 20-40% (3) 40-60% (4) 60-80% (5) 80-100%

14. In today's construction dollar, what is the approximate volume of C.M. work which your company can handle <u>at one time</u> with your present workforce?

(1) less than $1 mill (2) $1-10 mill (3) $10-20 mill (4) $20-30 mill (5) over $30 mill

15. What percent of your company's in-place construction volume (dollars), over the last five years, has been generated by CONSTRUCTION MANAGEMENT jobs?

(1) 0-20% (2) 21-40% (3) 41-60% (4) 61-80% (5) 81-100%

To what extent have you and your managers found the following to be useful as sources of information for managing your company's CONSTRUCTION MANAGEMENT contracts more efficiently?

16. <u>Professional journals</u>

1 (Not at all useful) 2 3 (Somewhat useful) 4 5 (Very useful)

17. <u>Seminars (in house)</u>

1 (Not at all useful) 2 3 (Somewhat useful) 4 5 (Very useful)

18. <u>Seminars (taught by professionals from outside your company)</u>

1 (Not at all useful) 2 3 (Somewhat useful) 4 5 (Very useful)

To what extent have you and your managers found the following to be useful as sources of information for managing your company's CONSTRUCTION MANAGEMENT contracts more efficiently? (Cont.)

19. Interacting with design firms

1	2	3	4	5
(Not at all useful)		(Somewhat useful)		(Very useful)

20. Manager's own experience

1	2	3	4	5
(Not at all useful)		(Somewhat useful)		(Very useful)

21. If you had to characterize your company's design would you say it was organized along:

1	2	3	4	5
(a LINE organization)		(a COMBINATION)		(a STAFF organization)

NOTE: **LINE** refers to an organizational design where decisions on all projects are made by the highest executive in the organization, and responsibilities for carrying out decisions are then delegated to employees.
STAFF refers to an organizational design where organizational authority is shared among several functional area managers, each of whom is responsible for his own area.
COMBINATION refers to an organizational design which is a blending of both LINE and STAFF.

This section of the questionnaire asks questions about the type of CONSTRUCTION MANAGEMENT projects which your company undertakes. Please circle the answer which best describes how you see your company in relationship to the question.

22. What is the approximate dollar value, excluding real estate cost, of the smallest CONSTRUCTION MANAGEMENT project which your company has done in the last five years?

(1) Less than $500K (2) $500K-1.5 mill (3) $1.5-5 mill (4) $5-10 mill (5) Over $10 mill

23. What is the approximate dollar value, excluding real estate cost, of the largest CONSTRUCTION MANAGEMENT project which your company has done in the last five years?

(1) Less than $1 mill (2) $1-10 mill (3) $10-20 mill (4) $20-30 mill (5) Over $

AD-A141 841 CONSTRUCTION MANAGEMENT PLANNING THE IMPACT ON MEETING OWNER GOALS(U) MICHIGAN STATE UNIV EAST LANSING D A BOOTHE 17 MAY 84 3/3

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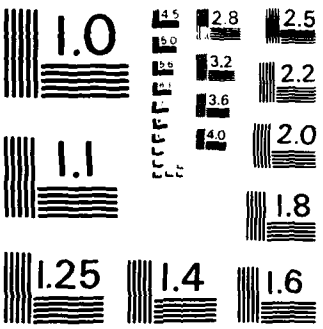


24. In your experience, once a CONSTRUCTION MANAGEMENT contract has been signed, what part of the time does your company have the major role in establishing team (owner, C.M., Architect-Engineer) communication procedures?

(1) Never (2) 1/3 (3) 1/2 (4) 2/3 (5) Always

25. What portion of your company's CONSTRUCTION MANAGEMENT contracts require a network based scheduling system as a requirement, not an option, of the owner?

(1) None (2) 1/3 (3) 1/2 (4) 2/3 (5) All

26. What part of the time is your company hired, under a CONSTRUCTION MANAGEMENT contract, prior to the Architect-Engineer being hired?

(1) Never (2) 1/3 (3) 1/2 (4) 2/3 (5) Always

27. What percent of your company's CONSTRUCTION MANAGEMENT jobs, over the last five years, were done for private, as opposed to public, owners?

(1) 0% (2) 1-25% (3) 25-50% (4) 50-75% (5) 75-100%

This section of the questionnaire asks questions about the planning which your company does during the pre-construction phase of a CONSTRUCTION MANAGEMENT project. Please circle the answer which best describes how you see your company in relationship to the question.

28. On what percent of your company's CONSTRUCTION MANAGEMENT jobs does one individual supervise the entire pre-construction phase of the project?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

29. On what percent of your company's CONSTRUCTION MANAGEMENT jobs is the supervision of the entire pre-construction phase shared by a team?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

30. What percent of the time does your company use computer generated schedules to assist in planning during the pre-construction phase?

(1) Never (2) 1-30% (3) 30-60% (4) 60-90% (5) Always

31. What percent of your company's CONSTRUCTION MANAGEMENT jobs incorporate 'Value Engineering' into planning during the pre-construction phase?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

32. On what proportion of your company's CONSTRUCTION MANAGEMENT jobs does your company use computerized estimating techniques during the pre-construction phase?

1	2	3	4	5
(no C.M. jobs)		(most C.M. jobs)		(all C.M. jobs)

33. To what extent do the steps which your company uses for planning a CONSTRUCTION MANAGEMENT job vary with the dollar value (size) of the job?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

34. On what percent of your company's CONSTRUCTION MANAGEMENT jobs does your company, during conceptual planning, set dates for completing the design phase?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

35. Once set, how often are the dates in your company's plan for the pre-construction phase formally updated?

1	2	3	4	5
(Daily)	(Semi-weekly)	(Weekly)	(Semi-monthly)	(Monthly or less often)

36. Does your company apply any formalized method of 'risk analysis' to the project during the conceptual stage?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

37. For what percent of the jobs does your company propose <u>design</u> alternatives during the pre-construction phase of a CONSTRUCTION MANAGEMENT project?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

38. For what percent of the jobs does your company propose <u>construction</u> alternatives during the pre-construction phase of a CONSTRUCTION MANAGEMENT project?

1	2	3	4	5
(Never)	(Rarely)	(Sometimes)	(Usually)	(Always)

39. In your experience, once a CONSTRUCTION MANAGEMENT contract has been signed, what percent of decisions affecting planning during the pre-construction phase is <u>actually</u> made by the OWNER?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

40. In your experience, once a CONSTRUCTION MANAGEMENT contract has been signed, what percent of decisions affecting planning during the pre-construction phase is actually made by the CONSTRUCTION MANAGER?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

41. In your experience, once a CONSTRUCTION MANAGEMENT contract has been signed, what percent of decisions affecting planning during the pre-construction phase is actually made by the Architect-Engineer?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

This section of the questionnaire asks questions about your company's experiences in the CONSTRUCTION MANAGEMENT field over the last FIVE years. Please circle the answer which describes how you see your company's performance.

42. What percent of your company's completed CONSTRUCTION MANAGEMENT jobs had a final cost equal to or less than the owner's original budget? (On average for the last five years.)

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

43. What percent of your company's completed CONSTRUCTION MANAGEMENT jobs had a final cost equal to or less than the final pre-bid estimate? (On average for the last five years.)

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

44. What percent of your company's CONSTRUCTION MANAGEMENT jobs were completed by the owner's original completion date? (On average for the last five years.)

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

45. What percent of your company's CONSTRUCTION MANAGEMENT jobs were completed by the date established during pre-construction planning? (On average for the last five years.)

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

46. Of the CONSTRUCTION MANAGEMENT jobs for which your company was asked to participate in a selection interview by an OWNER, what percent did your company actually contract for?

(1) None (2) 1-30% (3) 30-60% (4) 60-90% (5) All

47. How do you believe your company's growth, over the last five years, compares with other companies of your size offering CONSTRUCTION MANAGEMENT services? (This is only in reference to the CONSTRUCTION MANAGEMENT portion of your company)

1	2	3	4	5
(Slower)		(Same)		(Faster)

This section of the questionnaire asks questions about your company during the latest completed fiscal year. Anticipating your sensitivity to some of the questions, I again would like to assure your that your responses will be strictly confidential. At no time will any of this information be known to anyone but myself. The quality and usefulness of the feedback which you receive from me and the usefulness of the information which you have already given depends upon the completeness of the questionnaire. I am not asking for specific figures, only ratios.

PLEASE CHECK ONE:

48. _____ These ratios are for the ENTIRE company

49. _____ These ratios are for the CONSTRUCTION MANAGEMENT Division only.

Please give the following ratios for the latest completed fiscal year:

50. Operating profit/gross fixed assets _____ %

51. Net profit after taxes/(Assets - Liabilities) _____ %

52. Income before taxes/Equity _____ %

*Please feel free to use the remaining space for any additional comments.

THANK YOU FOR YOUR TIME AND EFFORT.

PLEASE FOLD YOUR COMPLETED QUESTIONNAIRE AND MAIL IT IN THE STAMPED ENVELOPE PROVIDED.

IF YOU REQUESTED A SUMMARY OF RESULTS, YOU WILL RECEIVE IT IN APPROXIMATELY SIX WEEKS.

THANK YOU.

APPENDIX C

STATISTICAL DEFINITIONS AND FORMULAS USED TO ANALYZE DATA

APPENDIX C

Statistical Definitions and Formulas Used to Analyze Data

MEAN: The sum of the individual values for each case divided by the number of cases.

$$\bar{x} = \frac{\Sigma x}{n}$$

Where $\bar{x}$ = sample mean

Σx = sum of values of all cases

n = number of cases in the sample

STANDARD DEVIATION: The square root of the averages of the squared distances of observations from the mean.

$$s = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n}}$$

Where s = standard deviation of the sample

Σ = symbol for the sum of all the $(x - \bar{x})^2$

x = the observation

$\bar{x}$ = the sample mean

n = the number of cases

RANGE: The minimum value given for a variable subtracted from the maximum value given.

PEARSON PRODUCT-MOMENT CORRELATION: The general formula for computing Pearson product-moment correlations is

$$r = \frac{\sum_{i=1}^{N} (X_i - \bar{X})(Y_i - \bar{Y})}{\left\{\left[\sum_{i=1}^{N} (X_i - \bar{X})^2\right]\left[\sum_{i=1}^{N} (Y_i - \bar{Y})^2\right]\right\}^{1/2}}$$

Where X_i = ith observation of variable X
Y_i = ith observation of variable Y
N = number of observations

$$\bar{X} = \sum_{i=1}^{N} X_i / N = \text{mean of variable X}$$

$$\bar{Y} = \sum_{i=1}^{N} Y_i / N = \text{mean of variable Y}$$

PARTIAL CORRELATION: The basic formula for the computation of partial-correlation coefficients is

$$r_{ij.k} = \frac{r_{ij} - (r_{ik})(r_{jk})}{\sqrt{1 - r_{ik}^2}\sqrt{1 - r_{jk}^2}}$$

Where k = the control variable

i = the independent variable

j = the dependent variable

(the order of i and j is immaterial)

APPENDIX D

KEY TO VARIABLES

APPENDIX D

KEY TO VARIABLES

Variable	Meaning
CSTOWNBG	Percent of CM jobs with final cost equal to or less than owner's original budget.
CSTPREBD	Percent of CM jobs with final cost equal to or less than final pre-bid estimate.
CMPEST	Percent of time computer estimating techniques used during preconstruction phase.
CMPPLN	Percent of time computer generated schedules used to assist in preconstruction planning.
COMGRWTH	CM company growth as compared to competition.
COMMO	Part of time the company has major role in establishing team (owner, CM, and A-E) communication procedures.
CONSTALT	Proposal of construction alternatives by CM.
COORGAN	Company organization.
DECBYAE	Percent of decisions affecting planning, during preconstruction, made by A-E.
DECBYCM	Percent of decisions affecting planning, during preconstruction, made by CM.
DECBYOWN	Percent of decisions affecting planning, during preconstruction, made by owner.
DESGNALT	Proposal of design alternatives by CM.
HIREBFAE	Part of the time the CM company is hired before the A-E.
INPLVOL	Percent of in-place construction volume (dollars) generated by CM contracts for last five years.

Variable	Meaning
INTERACT	Interaction with design firms useful as a source of CM contract management information.
JOBOWNDT	Percent of CM jobs completed by owner's original completion date.
JOBPREDT	Percent of CM jobs completed by date set during preconstruction planning.
JOBSCNT	Percent of CM jobs actually contracted for after participating in owner's selection interview.
MANGREXP	Manager's own experience useful as a source of CM contract management information.
NTWRKSYS	Part of CM contracts which require a network based scheduling system as a requirement of the owner.
NUMBRNCH	Number of branch offices.
NUMCMCTS	Number of CM contracts completed in last five years.
NUMEMPFL	Number of full time employees.
ONESUPER	Percent of CM jobs with one supervisor for preconstruction phase.
PLNUPDT	Formal updating of plan for preconstruction phase.
PLNVSSIZ	Extent to which planning steps vary with project size.
PRECONEM	Percent of preconstruction phase employees who are permanent.
PROFJOUR	Professional journals useful as a source of CM contract management information.
PVTJOBS	Percent of CM jobs done for private, as opposed to public, owners over last five years.
RISKANL	Application of formalized method of "risk analysis" during the conceptual stage.
SEMBYPRO	Seminars by professionals useful as a source of CM contract management information.

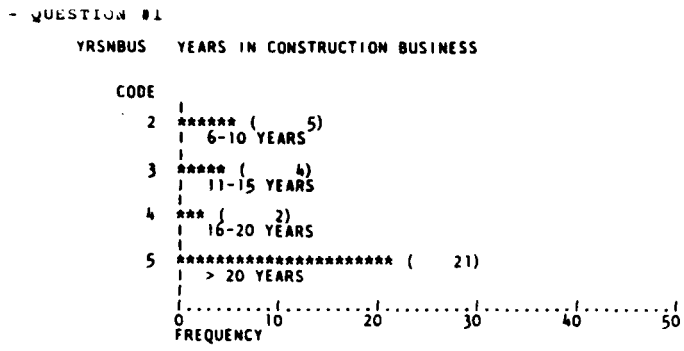
Variable	Meaning
SEMNHOUS	In-house seminars useful as a source of CM contract management information.
SETDTDES	Percent of CM jobs on which dates for completing the design phase are set during conceptual planning.
TMSUPER	Percent of CM jobs with team supervision for preconstruction phase.
VALCMCTS	Value (dollars) of CM contracts completed in last five years.
VALENG	Percent of time "value engineering" incorporated into preconstruction planning.
VALLGPRJ	Value (dollars) of largest CM project in la five years.
VALSMPRJ	Value (dollars) of smallest CM project in last five years.
VOLWKPRS	Volume (dollars) of CM contracts which can be handled with present workforce.
YRSNBUS	Years in the construction industry.
YRSNCM	Years offering CM services.
YRSNHSE	Years of in-house design capability.

APPENDIX E

FREQUENCY HISTOGRAMS

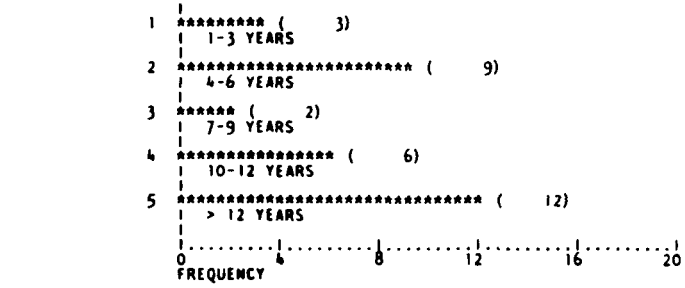
- QUESTION #1

YRSNBUS YEARS IN CONSTRUCTION BUSINESS



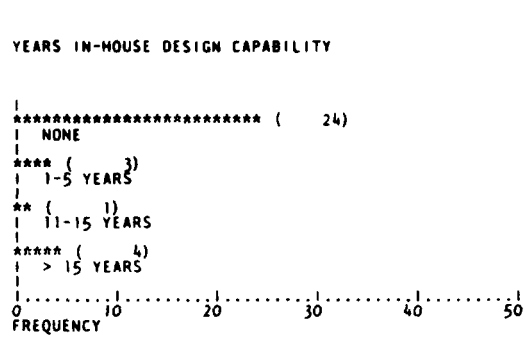
- QUESTION #2

YRSNCM YEARS IN CM



- QUESTION #3

YRSNHSE YEARS IN-HOUSE DESIGN CAPABILITY



- QUESTION #4

NUMBRNCH NUMBER OF BRANCH OFFICES

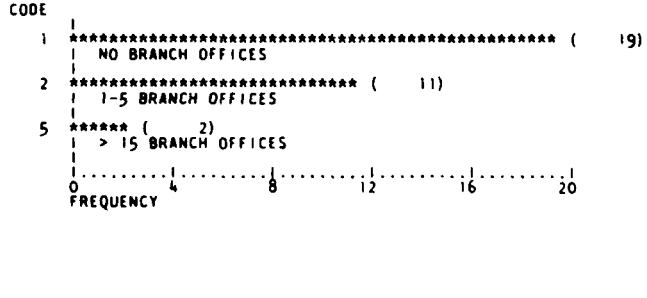
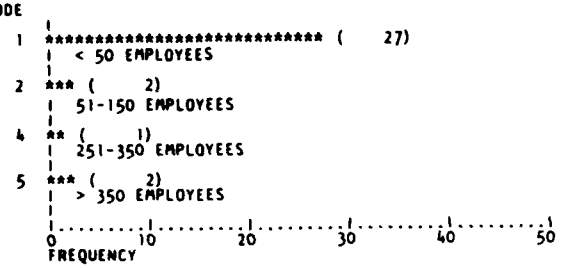


Figure E.1 Frequency Histograms

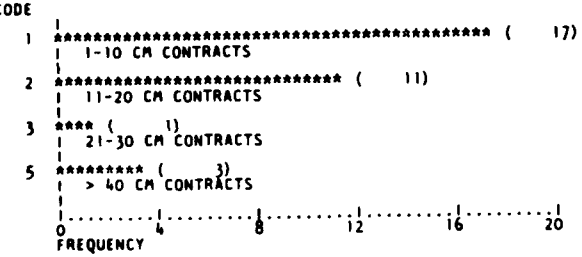
- QUESTION #10

NUMEMPFL NUMBER OF FULL TIME EMPLOYEES



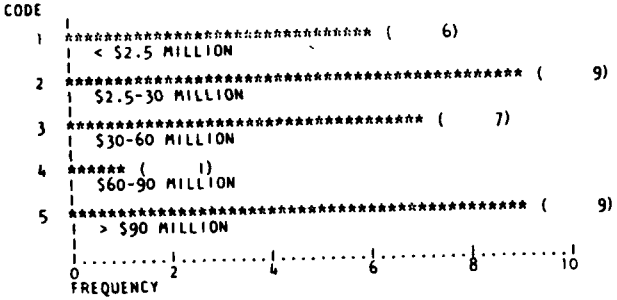
- QUESTION #11

NUMCMCTS NUMBER OF CM CONTRACTS IN LAST 5 YEARS



- QUESTION #12

VALCMCTS VALUE OF CM CONTRACTS IN LAST 5 YEARS



- QUESTION #13

PRECONEM PERCENT OF PRECON PLAN EMPL PERMANENT

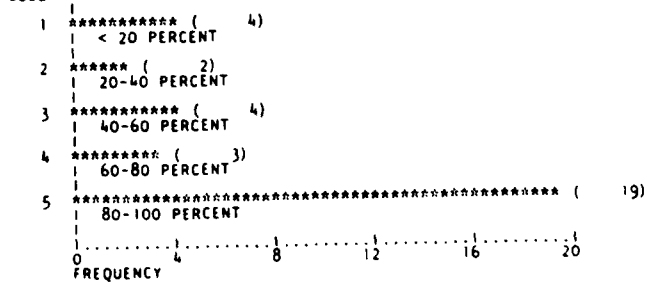
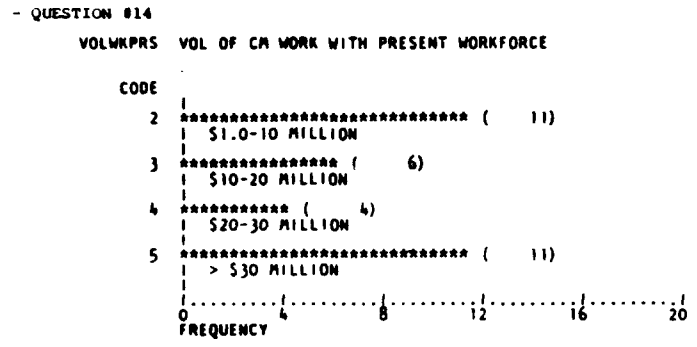
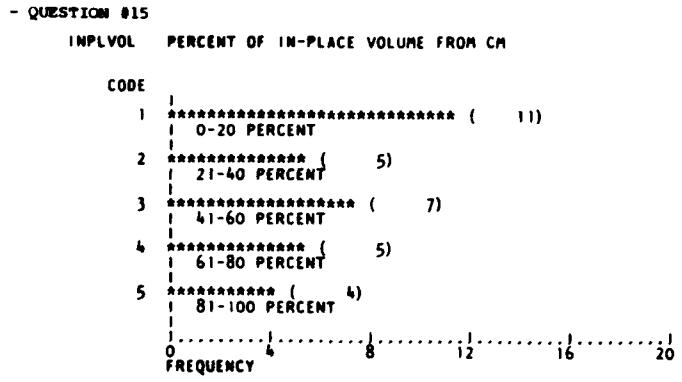
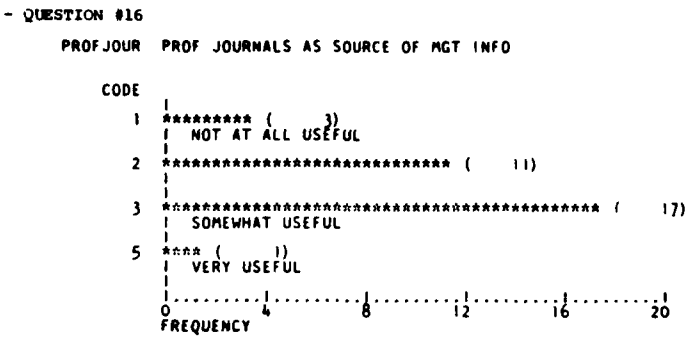


Figure E.1 (cont'd)







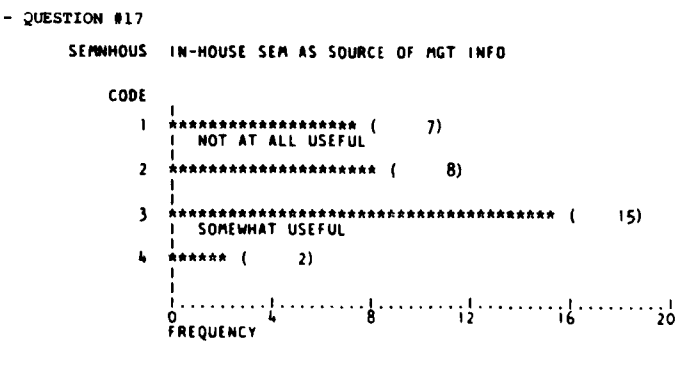
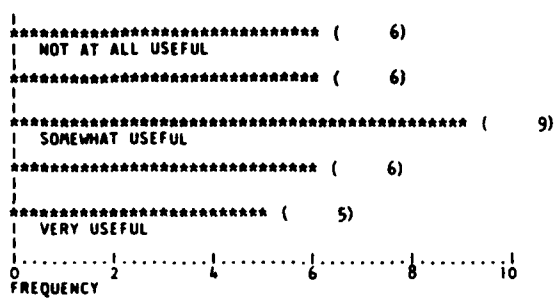


Figure E.1 (cont'd)

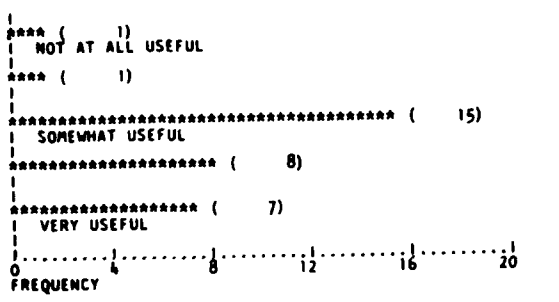
- QUESTION #18

SEMBYPRO SEMINARS BY PROF FOR MGT INFO



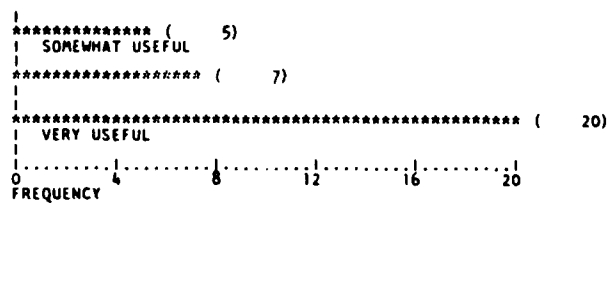
- QUESTION #19

INTERACT INTERACT W-DESIGN FIRMS FOR MGT INFO



- QUESTION #20

MANGREXP MANAGERS' OWN EXP AS MGT INFO SOURCE



- QUESTION #21

COORGAN COMPANY ORGANIZATION

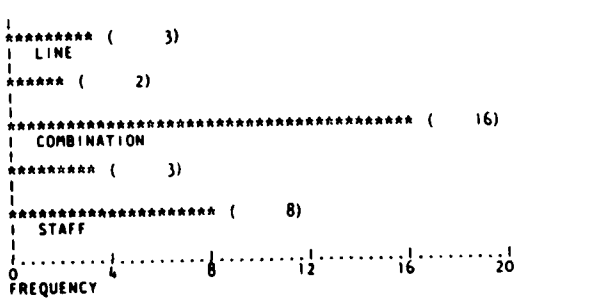


Figure E.1 (cont'd)

- QUESTION #22

VALSMPRJ VALUE OF SMALLEST CM JOB IN LAST 5 YRS

CODE

1 ********** (18)
< $500K

2 ********* (9)
$500K - $1.5 MILLION

3 ******** (4)
$1.5 - $5 MILLION

4 **** (1)
$5 - $10 MILLION

0 4 8 12 16 20
FREQUENCY

- QUESTION #23

VALLGPRJ VALUE OF LARGEST CM JOB IN LAST 5 YRS

CODE

1 ******** (4)
< $1.0 MILLION

2 ********** (15)
$1.0 - $10 MILLION

3 ****** (2)
$10 - 20 MILLION

4 ******** (4)
$20 - $30 MILLION

5 ********** (7)
> $30 MILLION

0 4 8 12 16 20
FREQUENCY

- QUESTION #24

COMMO MAJOR ROLE IN EST MGT TEAM COMMO PROCED

CODE

1 **** (1)
NEVER

2 ********** (8)
ONE-THIRD OF TIME

3 ********** (8)
ONE-HALF OF TIME

4 ********* (3)
TWO-THIRDS OF TIME

5 ********** (12)
ALWAYS

0 4 8 12 16 20
FREQUENCY

- QUESTION #25

NTWRKSYS NETWORK SCHED SYS REQUIRED BY OWNER

CODE

1 ********** (6)
NONE OF THE TIME

2 ********** (10)
ONE HALF OF THE TIME

3 ********** (7)
ONE-HALF OF THE TIME

4 ********** (4)
TWO-THIRDS OF THE TIME

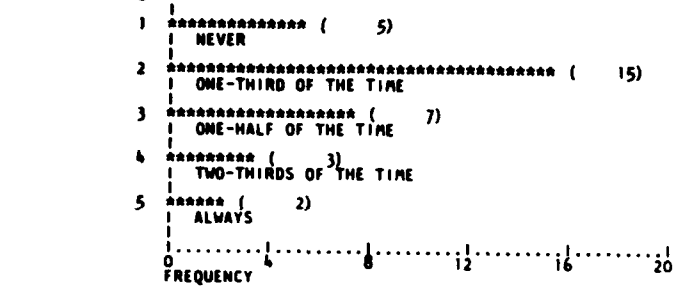
5 ********** (5)
ALL OF THE TIME

0 2 4 6 8 10
FREQUENCY

Figure E.1 (cont'd)

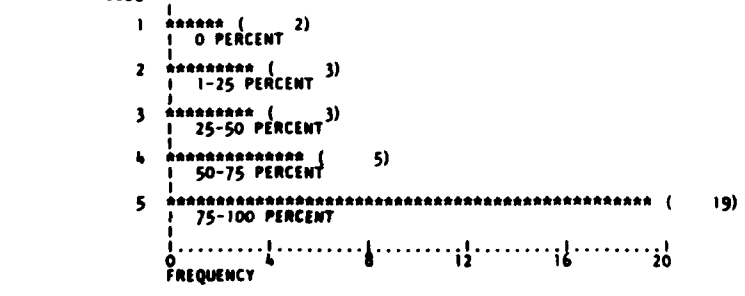
- QUESTION #26

HIREDFAE CM FIRM HIRED BEFORE A-E



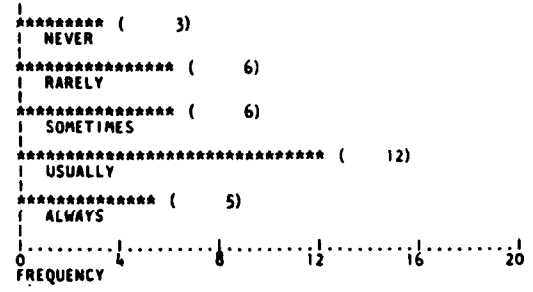
- QUESTION #27

PVTJOBS PERCENT JOBS FOR PRIVATE OWNERS



- QUESTION #28

ONESUPER ONE INDIV SUPERVISE PRECONST PLANNING



- QUESTION #29

TMSUPER TEAM SUPERVISES PRECONST PLANNING

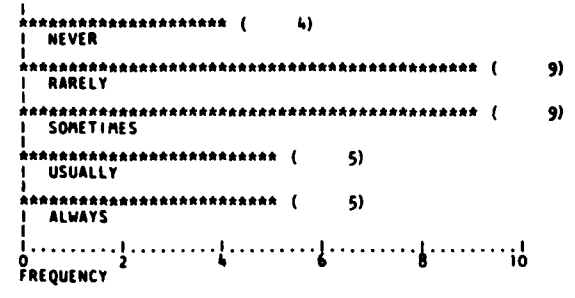
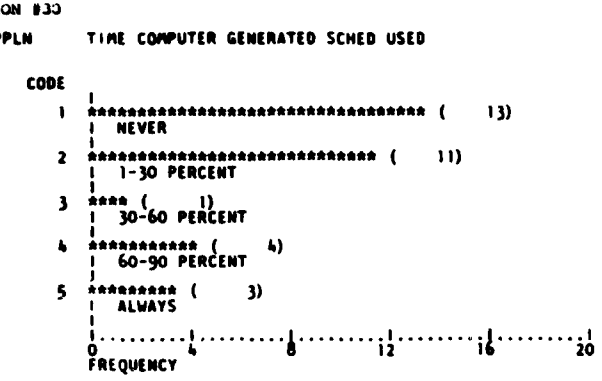


Figure E.1 (cont'd)

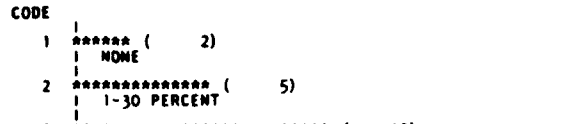
- QUESTION #30

CMPPLN TIME COMPUTER GENERATED SCHED USED



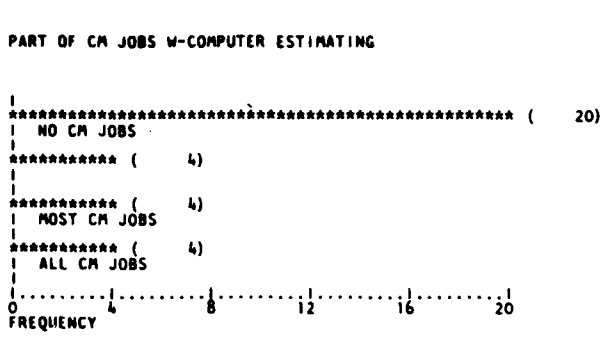
- QUESTION #31

VALENG TIME VALUE ENGR USED



- QUESTION #32

CMPEST PART OF CM JOBS W-COMPUTER ESTIMATING



- QUESTION #33

PLNVSSIZ PLANNING VARIES WITH VALUE OF JOB

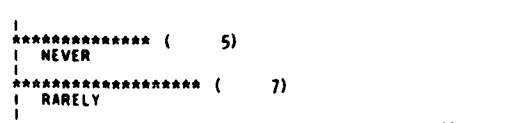
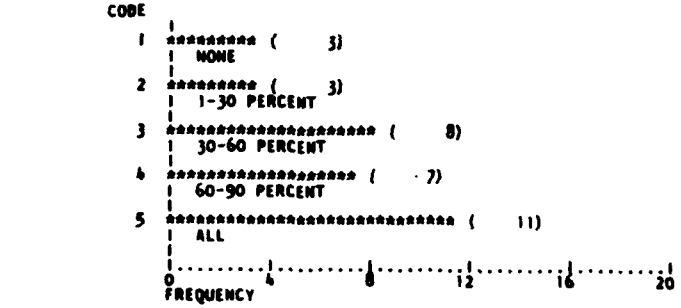


Figure E.1 (cont'd)

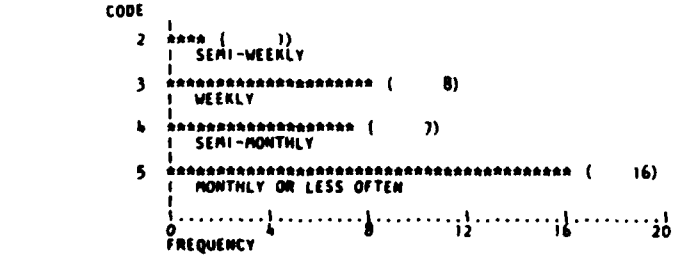
- QUESTION 034

SETDTDES SET DATES FOR COMPLETING DESIGN PHASE (DURING CONCEPTUAL PLAN)



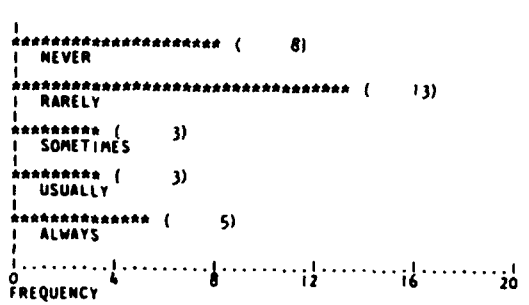
- QUESTION 035

PLNUPDT PLANS UPDATED DURING PRECONST PLANNING



- QUESTION 036

RISKANL APPLICATION OF FORMAL RISK ANALYSIS



- QUESTION 037

DESGNALT DESIGN ALTERNATIVES PROPOSED - PLANNING

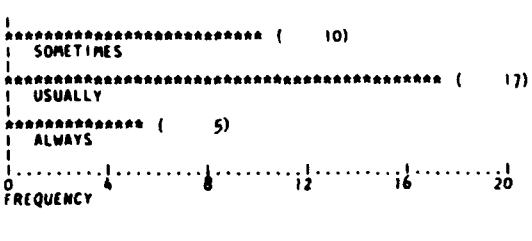
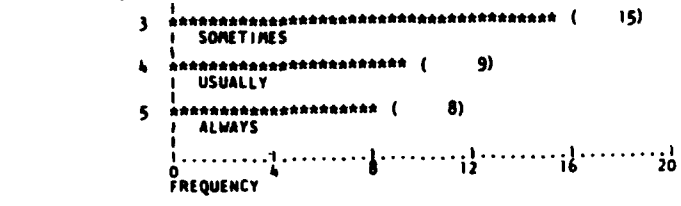


Figure E.1 (cont'd)

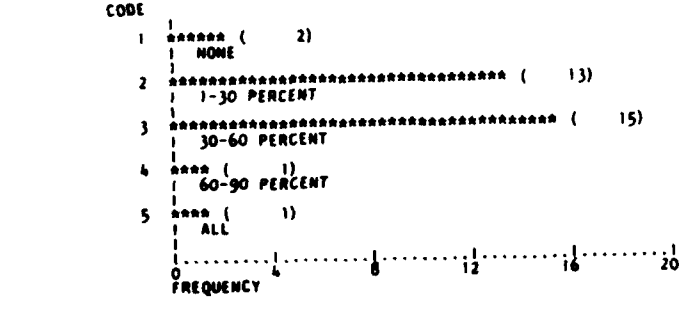
- QUESTION #38

CONSTALT CONST ALTERNATIVES PROPOSED - PLANNING



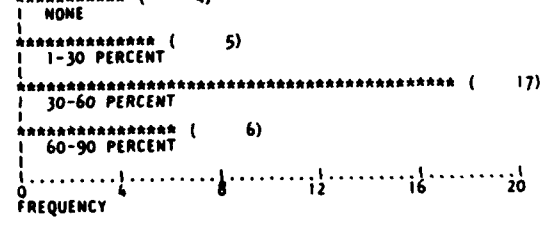
- QUESTION #39

DECBYOWN PLANNING DECISIONS BY OWNERS



- QUESTION #40

DECBYCM PLANNING DECISIONS BY CM



- QUESTION #41

DECBYAE PLANNING DECISIONS BY A-E

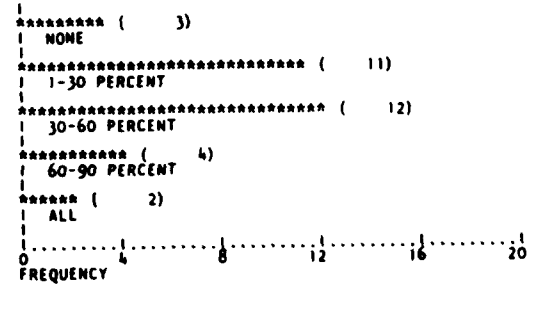


Figure E.1 (cont'd)

- QUESTION 042

CSTOWNBG CM JOBS FIN COST =< OWNER'S ORIG BUDGET

CODE

1 **** (1)
NONE

2 ****** (2)
1-30 PERCENT

3 ********** (8)
30-60 PERCENT

4 ********** (16)
60-90 PERCENT

5 ********** (5)
ALL

0 4 8 12 16 20
FREQUENCY

- QUESTION 043

CSTPREBD CM JOBS FIN COST =< FINAL PRE-BID EST

CODE

1 ********* (3)
NONE

2 **** (1)
1-30 PERCENT

3 ********** (5)
30-60 PERCENT

4 ********** (16)
60-90 PERCENT

5 ********** (7)
ALL

0 4 8 12 16 20
FREQUENCY

- QUESTION 044

JOBOWNDT CM JOBS FIN BY OWNER'S ORIG DATE

CODE

1 **** (1)
NONE

2 ********** (5)
1-30 PERCENT

3 ********** (5)
30-60 PERCENT

4 ********** (20)
60-90 PERCENT

5 **** (1)
ALL

0 4 8 12 16 20
FREQUENCY

- QUESTION 045

JOBPREDT CM JOBS FIN BY DATE SET IN PRECONST

CODE

2 *** (2)
1-30 PERCENT

3 ******** (7)
30-60 PERCENT

4 ********** (21)
60-90 PERCENT

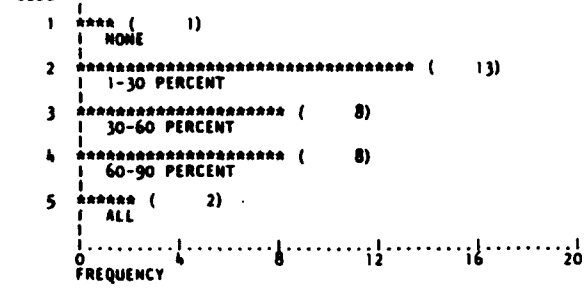
5 *** (2)
ALL

0 10 20 30 40 50
FREQUENCY

Figure E.1 (cont'd)

- QUESTION 046

JOBSCNT CM JOBS ACTUALLY CONTRACT FOR



- QUESTION 047

COMGRWTH COMPANY'S GROWTH COMPARED WITH OTHERS

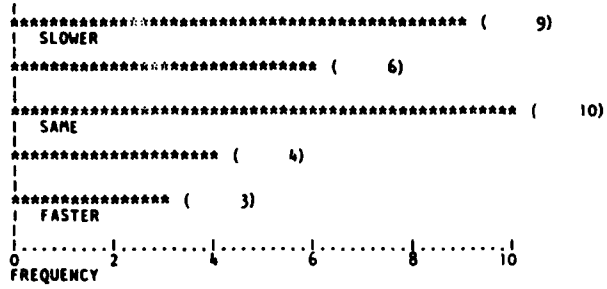


Figure E.1 (cont'd)

APPENDIX F

PEARSON CORRELATION MATRIX

APPENDIX F

Table F.1 Pearson Correlation Matrix

VARIABLE	YRSNBUS	YRSNCM	YRSNHSE	NUMBRNCH	NUMEMPFL	NUMCMCTS	VALCMCTS	PRECONEM	VOLWKPRS	INPLVOL	PROFJOUR	SEMNHOUS	SEMBYPRO	INTERACT
YRSNBUS	1.00	.23	.14	.32* [a]	.25	.33*	.14	.41**	.33*	.17	-.16	-.17	-.07	.11
YRSNCM	.23	1.00	-.13	.20	-.002	.41**	.13	.23	.22	.15	-.19	-.21	-.05	-.24
YRSNHSE	.14	-.13	1.00	.02	.25	.09	.02	.17	-.08	.25	-.13	-.03	-.25	.07
NUMBRNCH	.32*	.20	.02	1.00	.50**	.73***	.51***	.19	.45**	-.10	-.36**	-.004	-.26	-.17
NUMEMPFL	.25	-.002	.25	.50**	1.00	.29	.48**	.25	.45**	.20	-.22	-.25	-.46**	-.05
NUMCMCTS	.33*	.41*	.09	.73***	.29	1.00	.50**	.38*	.57***	.13	-.25	-.07	-.17	-.02
VALCMCTS	.14	.13	.02	.51***	.48**	.50**	1.00	.16	.81***	.56***	-.16	-.05	-.42**	-.11
PRECONEM	.41**	.23	.17	.19	.25	.39*	.16	1.00	.38*	.33*	-.42**	-.33*	-.23	.19
VOLWKPRS	.33*	.22	-.08	.45**	.45**	.57***	.81***	.38*	1.00	.37*	-.12	-.18	-.45**	-.07
INPLVOL	.17	.15	.25	-.10	.19	.13	.56***	.33*	.37*	1.00	-.04	.06	-.15	.21
PROFJOUR	-.16	-.18	-.13	-.36*	-.22	-.25	-.16	-.42**	-.12	-.04	1.00	.34*	.30*	.24
SEMNHOUS	-.17	-.21	-.03	-.004	-.25	-.07	-.05	-.33*	-.18	-.06	.34*	1.00	.60***	.32*
SEMBYPRO	-.07	-.05	-.25	-.26	-.46**	-.17	-.42**	-.23	.45**	-.15	.30*	.60***	1.00	.40*
INTERACT	.11	-.24	.07	-.17	-.05	-.02	-.11	.19	-.07	.21	.24	.32*	.40*	1.00
MANGREXP	.13	.46*	.05	.004	.03	.15	-.23	.56***	-.10	-.02	-.10	-.12	.06	.22
COORGAN	-.01	.09	-.07	.38*	.33*	.46*	.56***	-.21	.47*	.13	.07	.11	-.13	.15
VALSMPRJ	-.18	.09	-.30*	-.11	-.07	-.25	.19	-.09	.08	-.007	-.08	-.11	.09	.08
VALLGPRJ	.08	.07	.10	.54***	.56***	.50**	.92***	.06	.74***	.44**	-.15	-.05	-.34*	-.14
COMMO	.07	-.05	.44**	.09	.36*	.06	-.03	.31*	.04	-.01	.09	-.14	-.22	.15
NTWRKSYS	-.09	-.12	-.04	.14	-.04	.25	.39*	.03	.46**	.09	-.05		-.06	.02
HIREBFAE	-.002	-.23	.46**	02	.39*	-.07	.08	.25	.13	.17	-.17	-.04	-.14	.08
PVTJOBS	.15	.05	.18	-.38*	-.15	-.27	-.51	.31*	-.25	-.04	.06	.15	.14	.32*

a. *p.=<.05, **p.=<.01, ***p.=<.001

Table E1 (cont'd)

VARIABLE	MANGREXP	COORGAN	VALSMPRJ	VALLGPRJ	COMMO	NTWRKSYS	HIREBFAE	PVTJOBS	ONESUPER	TMSUPER	CMPPLN	VALENG	CMPEST	PLNVSSIZ
YRSNBUS	.13	-.01	-.18	.08	.07	-.09	-.002	.15	.06	-.10	.26	-.14	.15	-.25
YRSNCM	.46**	.09	.09	.07	-.05	-.12	-.23	.05	-.10	.10	.14	.10	-.11	-.02
YRSNHSE	.05	-.07	-.30*	.10	.44**	-.04	.46**	.18	.19	-.17	.08	.01	-.10	.23
NUMBRNCH	.003	.38*	-.11	.54***	.09	.14	.02	-.38*	-.02	.08	.50**	.17	.08	-.04
NUMEMPFL	.03	.33*	-.07	.56***	.36*	-.04	.39*	-.15	-.19	.32*	.24	.12	-.11	.19
NUMCMCTS	.15	.46**	-.25	.50**	.06	.25	-.07	-.28	.14	-.10	.41**	.23	.10	-.21
VALCMCTS	-.23	.56***	.19	.92***	-.03	.40*	.08	-.51***	-.09	.08	.24	.35*	.37*	-.12
PRECONEM	.56***	-.21	-.09	.06	.30*	.03	.25	.31*	-.07	.07	.13	.08	.01	-.16
VOLWKPRS	-.10	.47**	.08	.75***	.04	.46**	.13	-.25	-.01	.02	.35*	.17	.43**	-.14
INPLVOL	.02	.13	-.01	.44**	-.01	.09	.17	-.04	-.16	.14	-.16	.13	.04	-.23
PROFJOUR	-.10	.07	-.08	-.15	.09	-.05	-.17	.06	.09	-.06	-.14	-.03	.06	-.13
SEMNHOUS	-.12	.11	-.11	-.05	-.14		-.04	.15	-.34*	.27	.11	-.23	.09	
SEMBYPRO	.06	-.13	.09	-.34*	-.22	-.06	-.14	.14	-.40*	.34*	-.07	-.13	.01	-.35*
INTERACT	.22	.15	.08	-.14	.15	.02	.08	.32*	-.35*	.39*	-.24	-.002	-.16	-.41**
MANGREXP	1.00	-.18	-.07	-.35*	.48**	-.20	.17	.46**	-.13	.13	.12	.20	-.40*	-.01
COORGAN	-.18	1.00	.04	.54***	-.12	.21	-.22	-.40*	-.12	.14	.12	.42**	.14	-.08
VALSMPRJ	-.07	.04	1.00	.28	.10	.06	.01	-.20	-.45**	.34*	-.09	.37*	.13	-.20
VALLGPRJ	-.35*	.54***	.28	1.00	.03	.35*	.19	-.57***	-.17	.19	.28	.36*	.32*	-.11
COMMO	.48**	-.12	.10	.03	1.00	.10	.49**	.17	.05	-.04	.33*	.23	-.07	.20
NTWRKSYS	-.20	.21	.06	.35*	.01	1.00	.26	-.43**	.30*	-.33*	.22	-.07	.61***	
HIREBFAE	.17	-.22	.01	.19	.49**	.26	1.00	.19	.02	.07	.15	.06	-.05	.15
PVTJOBS	.46**	-.40*	-.20	-.57***	.17	-.43**	.19	1.00	-.13	.16	-.18	-.22	-.37*	-.02

Table E1 (cont'd)

VARIABLE	SETDTDES	PLNUPDT	RISKANL	DESGNALT	CONSTALT	DECBYOWN	DECBYCM	DECBYAE	CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT	JOBSCMCT	COMGRWTH
YRSNBUS	-.24	.05	-.30*	-.08	.02	.38*	.14	-.43**	-.02	-.02	.11	.08	-.01	.21
YRSNCM	-.17	.24	-.10	.20	-.02	.29	-.02	-.10	.48**	.50**	.14	.23	-.06	.11
YRSNHSE	.20	-.03	.03	.12	.16	.25	-.004	-.12	-.03	-.14	.22	.21	.20	-.13
NUMBRNCH	.22	.12	.17	-.10	-.19	.40**	-.28	-.30*	.07	.04	.14	.20	-.10	.13
NUMEMPFL	.18	.24	-.16	-.13	-.04	.17	.12	-.27	-.12	-.14	.31*	.29	.32*	.08
NUMCMCTS	.19	.24	.19	-.12	-.12	.75***	-.47**	-.32*	.23	.22	.25	.20	-.20	.29
VALCMCTS	.20	.29	.17	-.11	-.14	.33*	-.32*	-.10	.15	.12	.26	.17	.21	.28
PRECONEM	.36*	.50**	-.18	.25	.23	.34*	.29	-.22	.53***	.38*	.56***	.57***	-.13	.42**
VOLWKPRS	.16	.32*	.03	-.21	-.17	.39*	-.13	-.21	.26	.24	.27	.30*	.06	.30*
INPLVOL	-.04	.23	-.05	.16	.16	.22	.02	.001	.14	.08	.41**	.17	.28	.35*
PROFJOUR	-.20	-.27	.33*	-.02	.03	.07	.08	-.01	-.12	-.04	-.39*	-.25	.02	.05
SEMNHOUS	.20	-.28	.28	.26	-.06	.06	-.01	-.23	-.20	-.05	-.18	-.03	-.34*	.01
SEMBYPRO	-.09	-.22	.22	.20	.05	-.09	.04	-.22	-.15	-.14	-.13	-.14	-.47**	-.09
INTERACT	.10	.05	.20	.05	.01	-.07	.26	-.25	-.14	-.08	.15	.11	.09	.17
MANGREXP	.34*	.42**	.11	.40*	.22	.14	.34*	-.24	.47**	.42**	.23	.45**	-.02	.41**
COORGAN	.06	.34*	.18	-.45**	-.47**	.19	-.46**	.03	-.33*	-.21	-.12	.004	.18	.10
VALSMPRJ	-.01	.14	.11	.29	.11	-.54***	.02	.25	.18	.33*	.11	.15	.10	-.07
VALLGPRJ	.12	.17	.22	-.06	-.06	.25	-.38*	-.10	.08	.05	.33*	.17	.19	.14
COMMO	.42**	.13	.34*	.31*	.32*	.04	.26	-.05	.27	.32*	.11	.53***	.18	.12
NTWRKSYS	.31*	-.01	.38*	-.36*	-.34*	.16	-.39*	.09	.09	.06	.10	.03	-.27	-.19
HIREBFAE	.35*	.04	.15	.23	.29	-.07	.20	-.29	.14	.05	.44**	.30*	.01	.003
PVTJOBS	.12	-.02	-.34*	.36*	.27	-.07	.63***	-.36*	.11	.29	.06	.19	-.09	.03

Table E1 (cont'd)

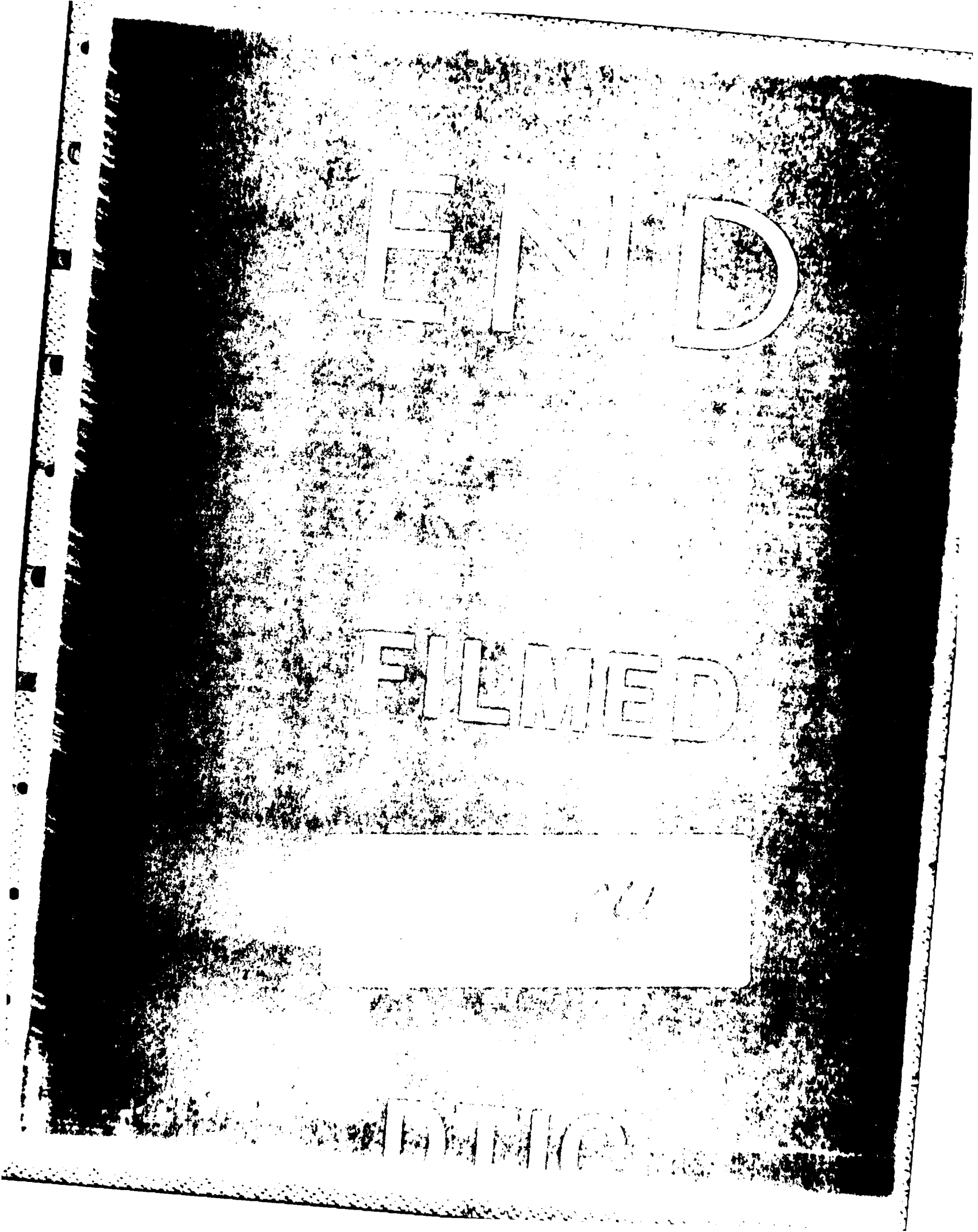
VARIABLE	YRSNBUS	YRSNCM	YRSNHSE	NUMBRNCH	NUMEMPFL	NUMCMCTS	VALCMCTS	PRECONEM	VOLWKPRS	INPLVOL	PROFJOUR	SEMNHOUS	SEMBYPRO	INTERACT
ONESUPER	.06	-.10	.19	-.02	-.19	.14	-.09	-.07	-.01	-.16	.09	-.34*	-.40**	-.35*
TMSUPER	-.10	.10	-.17	.08	.32*	-.10	.08	.07	.02	.14	-.06	.27	.34*	.39**
CMPPLN	.26	.14	.08	.50**	.24	.41**	.24	.13	.35*	-.16	-.14	.11	-.07	-.24
VALENG	-.14	.10	.01	.17	.12	.23	.35*	.08	.17	.13	-.03	-.23	-.13	-.002
CMPEST	.15	-.11	-.10	.08	-.11	.10	.37*	.01	.43**	.04	.06	.09	.01	-.16
PLNVSSIZ	-.25	-.02	.23	-.04	.19	-.21	-.12	-.16	-.14	-.23	-.13		-.35*	-.41**
SETDTDES	-.24	-.17	.20	.22	.18	.19	.20	.36*	.16	-.04	-.20	.20	-.09	.10
PLNUPDT	.05	.24	-.03	.12	.24	.24	.29	.50**	.33*	.23	-.26	-.28	-.22	.05
RISKANL	-.30*	-.10	.03	.17	-.16	.19	.17	-.18	.03	-.05	.33*	.28	.22	.20
DESGNALT	-.08	.20	.11	-.10	-.13	-.12	-.11	.25	-.21	.16	-.02	.26	.20	.05
CONSTALT	.02	-.02	.16	-.19	-.04	-.12	-.14	.23	-.17	.16	.03	-.06	.05	.01
DECBYOWN	.38*	.29	.25	.41**	.17	.74***	.33*	.34*	.39**	.22	.07	.06	-.09	-.07
DECBYCM	.14	-.02	-.004	-.28	.12	-.47**	-.32*	.29	-.13	.02	.08	-.01	.04	.26
DECBYAE	-.02	.48**	-.03	.07	-.12	.23	.15	.53***	.26	.14	-.12	-.20	-.15	-.14
CSTPREBD	-.02	.50**	-.14	.04	-.14	.22	.12	.38*	.25	.08	-.04	-.05	-.14	-.08
JOBOWNDT	.11	.14	.22	.14	.31*	.25	.26	.56***	.27	.41**	-.39**	-.18	-.13	.15
JOBPREDT	.08	.23	.21	.20	.28	.20	.17	.57***	.30*	.17	-.25	-.03	-.13	.11
JOBSCNT	-.01	-.06	.20	-.10	.32*	-.20	.21	-.13	.06	.28	.02	-.34*	-.50**	.10
COMGRWTH	.21	.11	-.13	.13	.08	.29	.28	.41**	.30*	.35*	.05	.01	-.09	.17
CSTOWNBG	-.02	.48**	-.03	.07	-.12	.23	.15	.53***	.26	.14	-.12	-.20	-.15	-.14

Table E1 (cont'd)

VARIABLE	MANGREXP	COORGAN	VALSMPRJ	VALLGPRJ	COMMO	NTWRKSYS	HIREBFAE	PVTJOBS	ONESUPER	TMSUPER	CMPPLN	VALENG	CMPEST	PLNVSSIZ
ONESUPER	-.13	-.12	-.45**	-.17	.05	.30*	.01	-.13	1.00	-.92***	.01	-.07	.16	.22
TMSUPER	.13	.14	.34*	.19	-.04	-.33*	.07	.16	-.92***	1.00	-.05	.08	-.24	-.19
CMPPLN	.12	.12	-.09	.28	.33*	.22	.15	-.18	.01	-.05	1.00	.04	.36*	.36*
VALENG	.20	.42**	.37*	.36*	.23	-.07	.06	-.22	-.07	.08	.04	1.00	.14	-.15
CMPEST	-.40*	.14	.13	.32*	-.07	.61***	-.05	-.37*	.16	-.24	.36*	-.14	1.00	
PLNVSSIZ	-.01	-.08	-.20	-.11	.20		.15	-.02	.22	-.19	.36*	-.15		1.00
SETDTDES	.34*	.06	-.01	.12	.42**	.31*	.34*	.12	-.01	-.05	.31*	.18	.08	.19
PLNUPDT	.42**	.34*	.14	.17	.13	-.03	.04	-.02	-.25	.15	-.02	.50**	-.06	-.14
RISKANL	.11	.18	.11	.22	.34*	.38*	.15	-.34*	.04	-.02	.28	.28	.15	-.06
DESGNALT	.40*	-.50**	.30	-.06	.31*	-.36*	.23	.36*	-.33*	.29	.28	.21	-.19	.16
CONSTALT	.22	-.47**	.11	-.06	.31*	-.34*	.29	.27	-.03	.09	.29	.29	-.19	.15
DECBYOWN	.14	.19	-.54***	.25	.04	.16	-.07	-.07	.27	-.28	.33**	.01	.24	-.12
DECBYCM	.34*	-.46**	.02	-.38*	.26	-.39*	.20	.63***	-.31*	.41**	.002	-.26	-.18	.10
DECBYAE	-.24	.03	.25	-.10	-.05	.09	-.29	-.36*	.20	-.29	-.27	.21	-.23	.33*
CSTPREBD	.42**	-.21	.33*	.05	.32*	.06	.05	.29	-.004	.01	.22	.21	.14	.02
JOBOWNDT	.23	-.12	.11	.33*	.11	.10	.44**	.06	-.25	.36*	-.06	.06	-.003	-.16
JOBPREDT	.45**	.003	.15	.19	.53***	.03	.30*	.19	-.35*	.39*	.50**	.17	.17	.24
JOBSCNT	-.02	.18	.11	.19	.18	-.27	.01	-.09	-.05	.17	-.15	.21	-.26	.12
COMGRWTH	.41**	.10	-.07	.14	.12	-.19	.003	.03	-.11	.08	.36*	.30*	-.07	-.10
CSTOWNBG	.49**	-.33*	.18	.08	.27	.09	.14	.11	.03	.01	.22	.17	.17	.05

Table E1 (cont'd)

VARIABLE	SETDTDES	PLNUPDT	RISKANL	DESGNALT	CONSTALT	DECBYOWN	DECBYCM	DECBYAE	CSTOWNBG	CSTPREBD	JOBOWNDT	JOBPREDT	JOBSCMT	CONGRMTH
ONESUPER	-.01	-.25	.04	-.33*	-.03	.27	-.31*	.20	.03	-.004	-.25	-.35*	-.05	-.11
TWSUPER	-.05	.15	-.02	.29	.08	-.28	.41**	-.29	.01	.01	.36*	.39*	.17	.08
CMPPLN	.31*	-.02	.28	.28	.29	.33*	.002	-.27	.22	.22	.06	.51**	-.15	.36*
VALENG	.18	.45**	.28	.21	.29	.01	-.26	.21	.17	.21	.06	.17	.21	.30*
CMPEST	.08	-.06	.15	-.19	-.19	.24	-.18	-.23	.17	.14	-.003	.17	-.26	-.07
PLNVSSIZ	.19	-.14	-.06	.16	.15	-.12	.10	.33*	.05	.02	-.16	.24	.12	-.10
SETDTDES	1.00	.24	.32*	.26	.04	.18	-.02	-.15	.22	.25	.04	.24	-.29	.09
PLNUPDT	.24	1.00	-.17	-.05	-.20	.11	-.14	.16	.07	.08	.16	.34*	-.08	.31*
RISKANL	.32*	-.17	1.00	.20	.10	.03	-.22	-.08	.27	.05	-.14	.12	.08	.18
DESGNALT	.26	-.05	.19	1.00	.80***	-.07	.36*	-.11	.53***	.57***	.17	.46**	-.07	.36*
CONSTALT	.04	-.20	.10	.80***	1.00	-.003	.36*	-.07	.41**	.41**	.18	.34*	.13	.45**
DECBYOWN	.18	.11	.03	-.07	-.003	1.00	-.31*	-.40*	.20	.21	.17	.06	-.33*	.25
DECBYCM	-.02	-.15	-.22	.36*	.36*	-.31*	1.00	-.28	.26	.19	.13	.42**	.29	.19
DECBYAE	-.15	.16	-.08	-.11	-.07	-.39*	-.28	1.00	-.13	-.10	-.23	-.12	.10	-.22
CSTPREBD	.25	.08	.05	.57***	.41**	.21	.19	-.10	.76***	1.00	.28	.47**	-.16	.24
JOBOWNDT	.04	.16	-.14	.17	.18	.17	.13	-.23	.44**	.28	1.00	.48**	.08	.15
JOBPREDT	.27	.34*	.12	.46**	.34*	.06	.42**	-.12	.57***	.47**	.48**	1.00	.10	.40*
JOBSCMT	-.29	-.08	.08	-.07	.13	-.33*	.29	.10	.002	-.16	.08	.10	1.00	.24
CONGRMTH	.10	.31*	.18	.36*	.45**	.25	.19	-.22	.36*	.24	.15	.40*	.24	1.00
CSTOWNBG	.22	.07	.27	.53***	.41**	.20	.26	-.13	1.00	.76***	.44**	.57***	.002	.35*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